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CONTENTS AND INDEX

NEW SERIES. VOL. LXXV—JANUARY TO JUNE, 1932

THE NAMES OF CONTRIBUTORS ARE PRINTED IN SMALL CAPITALS

bot, C. G., Solar and Radio Periodicities, 607
stracts, Authors', M. I. Goldman, 103
ademic Freedom in Italy, A. J. Carlson, 338; G. Montalenti, 414; in Spain, P. H. Yancey, 415, 537; J. F. Nonidez, 488
ademy of, Science, Texas, H. P. Parks, 81; Ohio, W. H. Alexander, 407, 668; Illinois, 508; Kansas, 508; Virginia, 508; Iowa, J. C. Gilman, 641; Tennessee, J. T. McGill, 669; Sciences, California, 352; National, Elections, 482; Papers, 543, 566, 592; Arts and Sciences, 557
Action Currents, L. E. Travis and T. A. Hunter, 220; Auditory, G. Kreezer and H. Darge, 105; Kreezer and Darge on, E. G. Wever and C. W. Bray, 267
Adrenal Glands, S. W. Britton and H. Silvette, 644
Agars, Vegetable Peptone, F. M. Bachmann and W. D. Frost, 440
Agricultural, Education, W. C. Coffey, 92; Bulletins, Distribution, J. G. Leach, H. Macy and C. H. Bailey, 104; Research, Appropriations for, 124; Engineers, *Amer. Soc. of*, 659
Ainu Pits in the Kurile Islands, M. L. Peelle, 562
Air Filtration, N. R. Smith, 199
Alexander, E. G., Staining Techniques for Tubercle Bacilli, 197
Alexander, J., Dust Particles, 194
Alexander, W. H., Ohio Academy of Science, 407, 668
llard, H. A., The Field Naturalist, 460
legany School of Natural History, 259
oxite as an Abrasive, E. J. Farris, 389
meel, D. J., The Muskrat, 382
American Association for the Advancement of Science, Science Booklists from, J. L. Wheeler, 20; New Orleans Meeting, Officers, 41; General Features, 141; Registration, 142; Press Service, 143; Science Exhibition, 144; Prize, 144; Proceedings of the Council, 146; President-elect, 147; Secretaries' Conference, 148; General Sessions, 149; Scientific Sessions: A—150, B—1, 152; C—5, 154; D—27, 155; E—155; F—156, 225; G—158; Organizations Related to both F and G, 161; H—162, 271; I—32, 163; K—164; L—165; M—166, 251; N—167; O—92, 168; Q—170; Organizations Related to all Sections, 171; Southwestern Division, 280; Pacific Division, 281, 377, 602; Syracuse Meeting, 328, Zoological Sessions, 456, Geological Sessions, 509; C. F. Roos, 141, 361, 408, 547; Symposia, 480; Proceedings of Executive Committee, C. F. Roos, 611
Ames, J. S., Henry on Electromagnetic Induction, 87
Anaerobic Bacteria, Cultivating, A. M. Griffin, 416
Anaplasmosis, Transmission of, C. W. Rees, 318
Anderson, E., How Big is a Cell?, 359
Anderson, R. L., Freezing Technique of Pigments, 316
Anderson, R. van V., Nature's Moving Picture, 357
Anthropologists, Appeal to, K. Dunlap and W. C. Beasley, 638
Anthropology Field, in Australia, J. B. Cleland, 50
Antigen Mixer, New Kahn, C. Subchot, 340
Antisyphilitic Agent, A. L. Tatum and G. A. Cooper, 541
Anti-vivisection Activity, 279
ant, F. S., and R. Knapp, Hookworm Larvae, 495
Arctic, Scientific Problems of, 209
sdell, S. A., Oestrus, 131
he, Pioneer Forester and Botanist, W. A. Dayton, 629
stronomy's Contribution to the Stream of Human Thought, D. W. Morehouse, 27
strophotographic Problems, Conference on, 609
Asymmetric Valleys and Climatic Boundaries, K. Bryan and S. L. Mason, 215
Atmometer Bulbs, Livingston, J. Stanley, 644
Atomic Nuclei, Properties of, G. I. Pokrowski, 443
Atwood, W. W., Ellen Churchill Semple, 657
Autotrophic Bacterium, C. B. Lipman and L. Greenberg, 192
Avian Coccidiosis, E. E. Tyzzer, 324

Bachmann, F. M., and W. D. Frost, Vegetable Peptone Agars, 440
Bacteria, The Changing, C.-E. A. Winslow, 121
Bacterial Life Cycle, H. Zinsser, 256
Baer's Law, Significance of, R. J. Russell, 584
Bailey, C. H., Award of the Osborne Medal to, 456
Baker, R. H., The Universe Unfolding, I. Barney, 641
Balance for Live Animals, B. F. Crocker and H. Wasteneys, 614
Bancroft, W. D., Wilhelm Ostwald, 454
Banting Research Foundation, 185
Barney, I., The Universe Unfolding, R. H. Baker, 641
Bauer, Louis Agricola (1865–1932), J. A. F., 452
Beach, F. E., Charles Sheldon Hastings, 428
Beaumont, A. B., Sodium Nitrate and Moss, 312
Beaver Dams, Boughs and Butts, C. E. Johnson, 132; Wood in, E. R. Warren, 194
Behavior, Animal, J. H. Welsh, 591
Behaviorism in Science, W. D. Tait, 462
Bentley, W. A. (The late), Conical Snow, 383
Bentley, Wilson Alwyn, W. J. Humphreys, 374
Bermuda, Biological Station, E. G. Conklin, 133; Glacial Control Theory Applied to, C. Schuchert, 264
Bernhard, A., and I. J. Drekter, Iron in Blood and Biological Fluids, 517
Berries Rich in Calcium, E. Yanovsky, E. K. Nelson and R. M. Kingsbury, 565
Biochemistry, Annual Review of, 556
Biochemists, Amer., Appeal to, R. H. Chittenden, P. A. Levene and L. B. Mendel, 609
Bioclimatics and Other Sciences, A. D. Hopkins, 535
Biological, Abstracts, 210; H. Hibbard, 380; C. E. McClung, 562; Sciences, Fellowships of Nat. Research Council, 235, 557
Biology Teachers, New York Assoc. of, 280
Birds, Sexual Maturity in, T. H. Bissonnette, 18
Birge, R. T., Fundamental Physical Constants, 383
Birth Rates and Death Rates, 658
Bishop, E. R., and M. Lawrenz, Cobalt in Plant Ash, 264
Bissonnette, T. H., Sexual Maturity in Birds, 18
Bleininger, A. V., Edward Orton, Jr., 277
Bless, A. A., Physics and Mathematical Preparation, 343
Bliss, S., Iron-Deficiency in Pellagra, 266
Blood, of the Hen, Hemoglobin Content, H. H. Dukes, L. H. Schwarte and A. E. Brandt, 25; Coagulation, J. H. Mueller and E. Sturgis, 140; and Biological Fluids, Iron in, A. Bernhard and I. J. Drekter, 517; -Inhabiting Protozoa, W. H. Taliaferro, 619
Boas, F., American Indian Languages, 489
Bobrovnikoff, N. T., Halley's Comet, C. P. Olivier, 359
Boltzmann, Ludwig, Monument for, 350
Boring, E. G., The Physiology of Consciousness, 32
Botanical Publication, N. E. Stevens, 499
Bowman, I., The Pioneering Process, 521
Bramble, W. C., Dormancy of Tree Seedlings, 193
Branchinecta Coloradensis, K. Gordon, 287
Branson, C. C., Conodonts in Permian of Wyoming, 337
Bridgman, P. W., Statistical Mechanics and the Second Law of Thermodynamics, 419

Brigham, Albert Perry, R. E. Dodge, 479
British, Physical and Optical Societies, 123; Assoc. for Advancement of Science, York Meeting, 507; Natural History Museum, 630
Britton, S. W., and H. Silvette, Adrenal Glands, 644
Broadfoot, W. C., Radiations and Gene Mutations, 334
Brooks, S. C., Thallium Poisoning and Soil Fertility, 105
Brown, B., Prospecting Pick, 291
Brues, B. B., Twisted Tree Trunks, 585
Bruno, Giordano, Process of, K. F. Herzfeld, 241
Bryan, K., and S. L. Mason, Asymmetric Valleys and Climatic Boundaries, 215
Bucher, W. H., "Strath" as a Geomorphic Term, 130
Burgess, C. F., Presentation of Perkin Medal to, 41
Burkett, G. W., Chromosomes in Althea rosea, 488
Byck, H. T., The pH of Water, 224

Caldwell, O. W., Science Essays by High School Pupils, 385
California Academy of Sciences, 352
Calmette Serum Trial, Convictions in, 208
Campbell, E. G., A Thermophil Nitrate Former, 23
Canavan, W. P. N., Broad Fish Tapeworm, 337
Cancer Research Foundation, International, 660
Cannon, W. A., Oxygen Content of Cultural Solutions, 108
Cannon, W. B., Wisdom of the Body, G. Lusk, 640
Carlson, A. J., Academic Freedom in Italy, 338
Carmichael, E. B., Removal of Hair, 136
Carotid Sinus Reflex and Origin of Vagal Tone, B. R. Lutz and L. C. Wyman, 590
Catholic Scientists, Round Table, A. M. Keefe, 245
Caylor, H. D., Roentgen Ray Films for Mounting Museum Specimens, 517
Cell, Size of, E. Anderson, 359
Celloidin, Embedding Material, P. Stockwell, 291
Chemical, Center in Chicago, 258; Soc., Amer., 234
Chemistry, Industrial Organic, and Research, J. F. Norris, 5; Lecturer at Cornell Univ., 75; Pure and Applied, Int. Congress, 124
Chemists and Chemical Engineers, Unemployment, 481
Chickens and Other Birds, Holder for, O. Seifried, C. B. Cain and H. Wulf, 315
Chidester, F. E., Goiter Producing Substances, 106; Vitamin A and the Iodin-fat Balance, 286
Chittenden, R. H., P. A. Levene and L. B. Mendel, Appeal to American Biochemists, 609
Chromosome Numbers, in Ulmus, R. I. Walker, 107; in Althea rosea, G. W. Burkett, 488
Clara, F. M., New Bacterial Disease of Pears, 111
Cleland, J. B., Field Anthropology in Australia, 50
Clouds, Rumbling and Luminous, J. Zeleny, 80
Cluster Fly, R. M. DeCoursey, 287
Cobalt in Plant Ash, E. R. Bishop and M. Lawrenz, 264
Coe, M. R., Light a Factor in Rancidity, 585
Coffey, W. C., Agricultural Education, 92
Colorimetric Analysis, R. H. Hamilton, Jr., 563
Colors, Entoptic, E. F. Way, 81; V. W. Lemmon, 217
Columbia Univ. Medical School, Master's Degree, 39
Compton, K. T., George Eastman, 402; Research Laboratories for Physics and Chemistry, 472
Conant, Professor, Award of the Chandler Medal, 12; Presentation of the Nichols Medal to, 305
Condon, E. U., Theory of Groups and Quantum Mechanics, H. Weyl, 586
Conel, J. LeR., Eggs of the Myzinoides, 19
Conklin, E. G., Bermuda Biological Station, 133
Connery, J. H., Mammoth Remains in Florida, 516
Conodonts, in Permian of Wyoming, C. C. Branson, 337
Consciousness, Physiology of, E. G. Boring, 32
Convulsions, Prevention of, E. J. Sheehy, 81
Cook, D. H., and J. Axtmayer, Vitamin A, 85
Copyright Bill, 406
Cornell Univ., Lecturer in Chemistry, 75
Cortico-adrenal Extract, E. Eagle and S. W. Britton, 221
Cosmic, Radiation, 577; Rays, 40, 329
Cotton, Root Rot Fungus, C. J. King, C. Hope and E. D. Eaton, 48; D. C. Neal, R. E. Wester and K. G. Gunn, 139; Plants, Leaf Temperatures, W. N. Ezekiel and J. J. Taubenhaus, 391; Growing, V. A. Tiedjens, 648
Craig, C. F., Salivary Secretions and Microfilariae, 561
Crampton, C. W., Durable Films, 537
Crocker, B. F., and H. Wasteneys, Balance for Live Animals, 614
Croneis, C., P. H. Dunn and D. Hunter, Pre-carboniferous Foraminifera, 138
Cultural, and Inoculation Methods, T. C. Vanderpool, 22; Solutions, Oxygen Content of, W. A. Cannon, 108
Culture Medium for Paramecium, L. E. Rosenberg, 3
Curphey, T. J., and H. B. Baruch, Immunology, 79
Curtis, W. C., Financing Scientific Research, 284

Daggs, R. G., and A. G. Eaton, Vitamin G in Tomato Juice, 222
Daland, J., Phila. Institute for Medical Research, 383
Davidson, J., and C. E. Chambliss, Chemical Composition of Rice, 294
Davis, H., A. Forbes and L. Garceau, The Analysis of Electromyograms, 436
Dayton, W. A., Ashe, Pioneer Forester and Botanist, 629
Decimal Place, Next, Romance of, F. K. Richtmyer, 1
DeCoursey, R. M., Feeding Habits of Larvae of Cluster Fly, 287
Desjardins, A. U., Radiosensitiveness of Cells and Tissues, 569
Deuber, C. G., Illuminating Gas and Trees, 496
Discovery and Discoverers, A. C. Klebs, 191
Disinfection, Theory of, M. L. Isaacs, 46
Dobrovolny, C. G., Micrographic Projector, 588
Dodds, G. S., The Soaring of Turkey Buzzards, 437
Dodge, R. E., Albert Perry Brigham, 479
Doisy, E. A., and S. A. Thayer, Oestrus-Producing Hormones, 216
Donaldson, H. H., American Physiological Society, 599
Dormancy of Tree Seedlings, W. C. Bramble, 193
Drake, C. J., H. M. Harris and H. D. Tate, Insects as Vectors of Yellow Dwarf of Onions, 341
Duck, Western, Sickness, E. R. Kalmbach, 57
Dukes, H. H., L. H. Schwarte and A. E. Brandt, Hemoglobin Content of the Blood of the Hen, 25
Dunlap, K., and W. C. Beasley, Appeal to Anthropologists, 638
Duryee, W. R., Water Content and Oxygen Consumption, 520
Dust, Particles, J. Alexander, 194; Meteoric, W. J. Fisher, 216

Eagle, E. and S. W. Britton, Cortico-adrenal Extract and Energy Output, 221
Eakin, H. M., Periglacial Phenomena, 536
Eastman, George, K. T. Compton, 402; Research Laboratories for Physics and Chemistry, K. T. Compton, 472
Eberson, F., The Etiology of Poliomyelitis, 519
Economic Theory, Hypothesis in, G. C. Evans, 321
Edison, Thomas Alva, 59–71; Appreciation of, C. L. Edgar, 59; Contributions to Science and Industry, F. B. Jewett, 65; as a Scientist, R. A. Millikan, 68; Laboratory in War Time, K. T. Compton, 70; Memorial, 233
Electromyograms, Analysis of, H. Davis, A. Forbes and L. Garceau, 436; L. E. Travis and T. A. Hunter, 639
Elm, American, Canker of, B. G. Richmond, 110
Elmer, O. H., Potato Sprouts and Apples, 193
Engineer, Problems of the, F. B. Jewett, 251
Engineering Societies Library, 187, 631
Engineers, Mining and Metallurgical, Inst. of, Awards of Medals, 236; Awards in England to, 580
"Entamoeba" Phallusiae, M. M. Metcalf, 19
Enzyme Action, F. F. Nord and O. M. von Ranke Abonyi, 54
Epidemiology, Experimental, L. T. Webster, 446

Epizootiology, E. L. TAYLOR, 288
Escherich, K., Die Forstinsekten Mitteleuropas, L. O. HOWARD, 218
Essays, Science, School, O. W. CALDWELL, 385
ESSIG, E. O., Insect Stinging Severely, 242
Eutopotropism, A. C. LANE, 393
EVANS, G. C., Hypothesis in Economic Theory, 321
EVANS, H. M., K. F. MEYER, R. PENCHARZ and M. E. SIMPSON, The Growth Hormone, 442
EWING, J., University and the Medical Profession, 173
Excursions, European, in 1932, O. A. JOHANNSEN, 289
Expedition, Scientific, International, 209
EZEKIEL, W. N., and J. J. TAUBENHAUS, Leaf Temperatures of Cotton Plants, 391

F., J. A., Louis Agricola Bauer (1865–1932), 452
FABER, H. K., Poliomyelitis, 198
Fairchild, Herman LeRoy, In Honor of, 126
FANCHER, G. H., and J. A. LEWIS, Flow of Fluids through Porous Media, 468
Faraday's Epoch, Our Debt to, D. C. JACKSON, 230
FARRIS, E. J., Aloxite as an Abrasive, 389; Preservation of the Human Body by Infiltration, 690
Fellowships, Yale, 432; of the Nat. Research Council, 235, 557
FELT, E. P., The Insect Menace, L. O. Howard, 360
FENTON, M. A., and C. L. FENTON, Taxonomy, 608
FERTIG, J. G., Scientific Research in the South, 595
Field, Museum of Natural History, 187, 351
FIFE, J. M., The Sugar-beet Leafhopper, 465
Films, Durable, C. W. CRAMPTON, 537
Filtration of Bacteria, A. I. KENDALL, 295
Financing Scientific Research, W. C. CURTIS, 284
FISCHER, A., Serum Albumin and Serum Globulins, 443
Fish, Hamivorous, W. A. HAMOR, 243
FISHER, W. J., Meteoric Dust, 216
FLEXNER, S., Wickliffe Rose, 504
Flow of Fluids through Porous Media, G. H. FANCHER and J. A. LEWIS, 468
Foraminifera, Pre-carboniferous, C. CRONEIS, P. H. DUNN and D. HUNTER, 138
Forest, Pine, of Costa Rica, P. C. STANDLEY, 437; Land, Government Controlled, 659
Forests, Succession of, J. E. POTZGER, 366; Experimental, in Minnesota, 578
Franklin, E. C., Willard Gibbs Medal to, 481
Franklin Institute, Medal Meeting, 531
FREUND, J., Immunization with Carbohydrate Haptens, 418
FUNK, C., and P. P. ZEFIROW, Sex Antagonistic Substance in Urine, 564

GARLOUGH, F. E., and J. C. WARD, Secondary Poisoning of Birds and Mammals, 335
Gastric Erosion of Metal, F. HOELZEL, 311
GATES, F. C., Flora of Central N. America, P. A. Rydberg, 667
Gelatins "Pure" and "Isoelectric," R. J. WILLIAMS, L. FRIEDMAN and D. M. WOODS, 199
Gels, Rhythmic Phenomena in, J. M. JOHLIN, 462
Genetics, Sixth International Congress of, 530; Society of America, 303
Geological, Award, Hayden Memorial for 1932, 237; Sessions of Summer Meeting of Amer. Assoc., 509
Geologists, Pennsylvania, Field Conference, 631
Geophysical Union, Amer., Research Committees of the Section of Hydrology of, 528
George Washington Univ., Honorary Degrees, 236
GIFFORD, J. C., and A. H. GILBERT, Prehistoric Mounds in South Florida, 313
GILMAN, J. C., Iowa Academy of Science, 641
GINSBURG, J. M., Airplane Oiling and Mosquitoes, 542
Glacial Control Theory Applied to Bermuda, C. SCHUCHERT, 264
Goiter-Producing Substances, F. E. CHIDESTER, 106
GOLDMAN, E. A., Control of Injurious Animals, 309
GOLDMAN, M. I., Authors' Abstracts, 103
GORDON, K., Branchinecta Coloradensis, 287
Granites and Rhyolites, W. A. TARR, 265
Grasshoppers, Fungous Diseases of, M. T. JAMES, 266
GRAVES, H. S., James William Toumey, 575
Great Britain, Importation of Specimens, 97
GREEN, E. L., Adding Load, 219
GREENE, H. C., and E. M. GILBERT, Single Spore Cultures of Molds, 388
GRIFFIN, A. M., Cultivating Anaerobic Bacteria, 416
Gronwall, Thomas H., J. F. RITT, 657
GROVE, B. H., Photomicrographic Apparatus for Obtaining Depth or Focus, 53
Guadalupe Island, 97
GUDGER, E. W., Fifth Florida Whale Shark, 412
GURCHOT, C., A New Kahn Antigen Mixer, 340
GUTHE, C. E., The Maya Lunar Count, 271

HADLEY, P., C Forms of Kuhn, 665
Hair, Removal of, E. B. CARMICHAEL, 136
HALLER, M. H., and D. H. ROSE, Apparatus for Determination of CO_2 and O_2 of Respiration, 439
HAMILTON, R. H., JR., Colorimetric Analysis, 563
HAMILTON, W. F., and E. FREEMAN, Trichromatic Functions of the Average Eye, 292
HAMOR, W. A., Hamivorous Fish, 243
HARRIS, M. B., Caecal Spirochetes, 498
Hartman, Frank A., Award of Chancellor's Medal, 330
Harvard, Observatory, Astrophotographic Building, 329; University, Geophysical Research at, 353
HARVEY, E. N., The Centrifuge Microscope, 267
Hastings, Charles Sheldon, F. E. BEACH, 428
HASTINGS, E. G., Twisting in Plants, 16; and J. McCARTER, Misnamed Cultures of the Tubercle Bacillus, 513
Hayden Award, Geological, 237
HEGNER, R., How the Other Half Lives, 225
Hematopoiesis, Control of, J. KRAFKA, JR., 194
Henry on Electromagnetic Induction, J. S. AMES, 87
HERRE, A. W., Whale Shark on Coast of Borneo, 413
Herty, Charles H., Award, 125
HERZFELD, K. F., The Processes of Giordano Bruno, 241
HIBBARD, H., Biological Abstracts and the College, 380
HIBBARD, P. L., Phosphate Dissolved from Soil, 464
HOELZEL, F., The Gastric Erosion of Metal, 311
HOLMES, S. J., Effects of Race Competition, 201
Hookworm Larvae, Rearing and Mounting, F. S. ARANT and R. KNAPP, 495
HOPKINS, A. D., Bioclimatics and Other Sciences, 535
Hormone, the Oestrus, R. K. MEYER and W. M. ALLEN, 111; the Growth, H. M. EVANS, K. F. MEYER, R. PENCHARZ and M. E. SIMPSON, 442
Horticulturist, Evolution of, T. H. MCHATTON, 469
HOWARD, L. O., Die Forstinsekten Mitteleuropas, K. Escherich, 218
Howard, L. O., The Insect Menace, E. P. FELT, 360
HOWARD, N. F., Twisted Trees, 132
HUBBLE, E. P., Extra-Galactic Nebulae, 24
Huber, Professor, Portrait, 557
HUMPHREYS, W. J., Robert DeCourcy Ward, 183; Wilson Alwyn Bentley, 374
HUNGATE, J. W., Northwest Scientific Assoc., 244
Hydrogen, Electrode and Apparatus for the Determination of pH, P. L. DU NOÜY, 643; -ion Concentration of the Tissues, C. VOEGTLIN and H. KAHLER, 362

Illinois Academy of Science, 508
Immunization with Carbohydrate Haptens, J. FREUND, 418
Immunology, T. J. CURPHEY and H. B. BARUCH, 79
Importation of Specimens and Apparatus into Great Britain, 97
Incorporation of Scientific Societies, B. E. LIVINGSTON, J. B. OVERTON and W. THOMAS, 438
Incubator, Multiple Laboratory, A. L. ROMANOFF, 246
Infiltration, *Preservation of Human Body by*, E. J. FARRIS, 670
Inheritance in Fragaria, G. L. RYGG and G. M. DARROW, 269

Injurious Animals, Control of, E. A. Goldman, 309
Insect Stinging Severely, E. O. Essig, 242
Insects, Separating, from Food, J. D. Wildman, 268; as Vectors of Yellow Dwarf of Onions, C. J. Drake, H. M. Harris and H. D. Tate, 341
Insulin, Chemical Study of, H. Jensen, 614
International Cooperation, 463
Iowa Academy of Science, J. C. Gilman, 641
Isaacs, M. L., A Theory of Disinfection, 46
Italian Professors and the Fascist Government, 73

Jackson, D. C., Our Debt to Faraday's Epoch, 230
James, M. T., Fungous Diseases of Grasshoppers, 266
Jenks, A. J., Pleistocene Man in Minnesota, 607
Jensen, H., Bufagin and Cinobufagin, 53; Chemical Study of Insulin, 614
Jesuit Fourth Vow, J. B. Macelwane, 562
Jewett, F. B., Edison's Contributions to Science and Industry, 65; Problems of the Engineer, 251
Johannsen, O. A., European Excursions in 1932, 289
Johlin, J. M., Rhythmic Phenomena in Gels, 462
Johns Hopkins Univ., Summer Session, 303
Johnson, C. E., Boughs, Butts and Beaver Dams, 132
Johnson, D., Physiography and the Dynamic Cycle, 636
Jones, E. P., Concentrating Paramecium, 52
Jones, W., Oospores of the Hop Downy Mildew, 108
Jordan, David Starr, Memorial, 72

Kalmbach, E. R., Western Duck Sickness, 57
Kansas, Academy of Science, 508
Kasner, E., General Theorems in Dynamics, 671
Keefe, A. M., Round Table of Catholic Scientists, 245
Kendall, A. L., The Filtration of Bacteria, 295
Kenk, R., Photographing Small Animals, 669
Kensington Museum, South, Anniversary, 601
Kinetic Systems, Laws of, W. H. Longley, 248
King, C. G., and W. A. Waugh, Vitamin C, 357
King, C. J., C. Hope and E. D. Eaton, Cotton Root Rot Fungus, 48
Klebs, A. C., Discovery and Discoverers, 191
Kleiber, M., Mercury Distillation, 196
Kligler, I. J., and M. Ashner, "Rickettsia" and "Symbionts," 133
Koch, Robert, In Memory of, 350
Krafka, J., Jr., Control of Hematopoiesis, 194
Kreezer, G., and H. Darge, Auditory Action Currents, 105
Krueger, A. P., Serial Dilution Method, 494
Kuhn, C Forms of, P. Hadley, 665

Lambert, W. D., Comité national Française de Géodésie et Géophysique, 313
Lamson, P. D., Manometer Writing Points, 137
Landauer, W., The Oestrus Cycle, 107
Lane, A. C., Eutopotropism, 393
Languages, American Indian, F. Boas, 489
Lay, G. W., Meter in Composition, 536
Leach, J. G., H. Macy and C. H. Bailey, Distribution of Experiment Station Bulletins, 104
Leaf Lipides, W. E. Tottingham, 223
Leafhopper, Sugar-beet, J. M. Fife, 465
Leidy, J., II, Leidy on Cretaceous Reptiles, 583
Lemmon, V. W., Entoptic Colors, 217
Leucocyte, Amphibian, A. W. Pollister, 390
Levine, P., and A. S. Anderson, Taste Blindness, 497
Light, Deflection of, in the Sun's Gravitational Field, R. J. Trumpler, 538; a Factor in Rancidity, M. R. Coe, 585
Lindbergh, C. A., Washing Corpuscles in Suspension, 415
"Line Contour," W. H. Wright, 130
Lipman, C. B., and L. Greenberg, New Autotrophic Bacterium, 192
Livingston, B. E., J. B. Overton and W. Thomas, Incorporation of Scientific Societies, 438
Load, Adding, E. L. Green, 219
Locusts, Investigation of, 351
London, Zoological Soc. of, 528
Longley, W. H., Laws of Kinetic Systems, 248
Lusk, G., Wisdom of the Body, W. B. Cannon, 640
Lutz, B. R., and L. C. Wyman, Carotid Sinus Reflex and Origin of Vagal Tone, 590
Lyon, M. W., Jr., Thallium Poisoning, 381

McClung, C. E., Indexes of Biological Abstracts, 562
McCoy, O. R., Adult Trichinae in Rats, 364
Macelwane, J. B., The Jesuit Fourth Vow, 562
McGill, J. T., Tennessee Academy of Science, 669
McHatton, T. H., Evolution of the Horticulturist, 469
McKaig, N., Jr., Moisture Percentages, 612
Magnetism and Electricity, A. W. Stern, 195
Mammoth Remains, J. H. Connery, 516
Manometer Writing Points, P. D. Lamson, 137
Margenau, H., Modern Physics, M. Planck, 338
Massachusetts Inst. of Tech., Retiring Members, 660
Mathematical Group, G. A. Miller, 102
Mathematicians, International Congress of, 455
Mather, Samuel, Obituary, T. Sollmann, 71
Mather, Stephen Tyng, in Commemoration of, 232
Maya Lunar Count, C. E. Guthe, 271
Mechanics, Statistical, and the Second Law of Thermodynamics, P. W. Bridgman, 419
Medaris, D., Washing Microscopical Tissues, 590
Medical, Profession and the University, J. Ewing, 173; Research, Philadelphia Inst. for, J. Daland, 383; Assoc., Amer., 432; Awards for Exhibits at New Orleans Meeting, 579
Mellon Institute, Progress in Research, 1931–32, 407
Mercury Distillation, M. Kleiber, 196
Merriam, C. H., Roosevelt, the Naturalist, 181
Metcalf, M. M., "Entamoeba" Phallusiae, 19
Meteorites in Sedimentary Rocks, W. A. Tarr, 17
Meteorological Soc., Royal, Exhibition of, 186
Meter in Composition, G. W. Lay, 536
Meyer, E. P. C., Early History of Platinum, 438
Meyer, R. K., and W. M. Allen, Oestrus Hormone, 111
Meyerhoff, H. A., Stratigraphy of Porto Rico, 342
Michigan, Univ. of, X-Ray Unit of the Hospital, 431
Micrographic Projector, C. G. Dobrovolny, 588
Microscope, Centrifuge, E. N. Harvey, 267; for Fluorescence in Living Tissues, E. Singer, 289
Miller, G. A., A Mathematical Group, 102
Miller, H. M., Jr., and M. L. Gardiner, Immunity to Infection with a Larval Tapeworm, 270
Miller, R. C., Determinism and the Weather, 413
Millikan, R. A., Edison as a Scientist, 68
Mills, J. E., Fundamental Physical Constants, 243
Mineral Research Program, Illinois, 73
Mineralogical Soc., Philadelphia, Exhibit, 431
Moisture Percentages, N. McKaig, Jr., 612
Molds, Cultures of, Single Spore, H. C. Greene and E. M. Gilbert, 388
Montalenti, G., Academic Freedom in Italy, 414
Morehouse, D. W., Astronomy's Contribution to the Stream of Human Thought, 27
Mosaic Disease Virus, P. K. Olitsky and F. C. Forsbeck, 518
Mosquito Population, E. Thomson, 78
Mosquitoes, Airplane Oiling to Control, J. M. Ginsberg, 542
Moving Picture, Nature's, R. van V. Anderson, 357
Mueller, J. H., and S. Sturgis, Blood Coagulation, 140
Murphy, J. B., and E. Sturm, Inhibitor for Tumors, 540
Murray, J. M., Polydactylism in Mice, 312
Murray, W. S., Effect of Ovariectomy on Breeding Females, 646
Museum, Tags, K. P. Schmidt, 23; Specimens, Roentgen Ray Films for, H. D. Caylor, 517
Muskrat, D. J. Ameel, 382
Myograph, Rotary, S. E. Owen, 245
Myxinoides, Eggs of the, J. LeR. Conel, 19

National, Academy of Sciences, 482, 543, 566, 592; Research Council, Fellowships, 235, 557; Grants-in-Aid, 259, 530

Naturalist, Field, H. A. Allard, 460
Nature, Sanctuaries, 481; Balance of, Upsetting, R. C. Smith, 649
Neal, D. C., R. E. Wester and K. C. Gunn, Cotton Root Rot, 139
Neanderthal Race in Palestine, 632
Nebulae, Extra-Galactic, E. P. Hubble, 24
Neisseria sicca, Pathogenicity of, F. W. Shaw, 488
Nelson, E. C., Cultivation of Troglodytella, 317
Nitrate, Sodium, and Moss, A. B. Beaumont, 312
Noise Measurement, Committee on, 210
Nonidez, J. F., Academic Freedom in Spain, 488
Nord, F. F., and O. M. von Ranke-Abonyi, Enzyme Action, 54
Norris, J. F., Research and Industrial Organic Chemistry, 5
du Noüy, P. L., Hydrogen Electrode and Apparatus for the Determination of pH, 643
Noyes, Arthur A., Award of Richards Gold Medal, 98

Oestrus, S. A. Asdell, 131; Cycle, W. Landauer, 107; Hormone, R. K. Meyer and W. M. Allen, 111;-Producing Hormones, E. A. Doisy and S. A. Thayer, 216
Ohio Academy of Science, W. H. Alexander, 407, 668
Olitsky, P. K., and F. C. Forsbeck, Mosaic Disease Virus, 518
Olivier, C. P., Halley's Comet, N. T. Bobrovnikoff, 359
Olmstead, L. B., and H. G. Byers, Soil Weights, 672
Oospores of the Hop Downy Mildew, W. Jones, 108
Ornithological Collection, Thayer, 11
Orton, Edward, Jr., A. V. Bleininger, 277; Ceramic Foundation, 375
Ostwald, Wilhelm, W. D. Bancroft, 454
Other Half, How it Lives, R. Hegner, 225
Ovariectomy, W. S. Murray, 646
Owen, S. E., A Rotary Myograph, 245

Pancreatectomy in the Dog, S. Soskin, 382
Paramecium and Rotifers, Concentrating, E. P. Jones, 52
Parks Association, National, 529
Parks, H. B., Texas Academy of Science, 81
Pasteur Institute, Tuberculosis Building at, 430
Patagonia, Expeditions to, W. B. Scott, 607
Pears, Bacterial Disease of, F. M. Clara, 111
Peelle, M. L., Ainu Pits in the Kurile Islands, 562; Whaling in Japanese Waters, 666
Pellagra, Iron-Deficiency in, S. Bliss, 266
Penney, J. T., Living Fresh-water Sponges, 341
Periglacial Phenomena, H. M. Eakin, 536
Petrographic Classification, W. C. Smith and A. K. Wells, 219
Philosophical Society, American, 457
Phosphate Dissolved from Soil, P. L. Hibbard, 464
Photographing Small Animals, R. Kenk, 669
Photomicrographic Apparatus, B. H. Grove, 53
Photomicrography, O. W. Richards, 107
Physical, Constants, J. E. Mills, 243, R. T. Birge, 383; Universe, Models of the, R. C. Tolman, 367; Society, American, 529
Physics, Reality in, W. F. G. Swann, 113; and Mathematical Preparation, A. A. Bless, 343
Physiography and the Dynamic Cycle, D. Johnson, 636
Physiological Society, Amer., H. H. Donaldson, 599
Physiology, *Journal* of Cellular and Comparative, 74
Pick, Prospecting, B. Brown, 291
Pigments, Freezing Technique for, R. L. Anderson, 316
Pioneering Process, I. Bowman, 521
Planck, M., Modern Physics, H. Margenau, 338
Platinum, Early History of, E. P. C. Meyer, 438
Pleistocene Man in Minnesota, A. J. Jenks, 607
Poisoning, Secondary, of Birds and Mammals, F. E. Garlough and J. C. Ward, 335
Pokrowski, G. I., Properties of Atomic Nuclei, 443
Poliomyelitis, H. K. Faber, 198; F. Enerson, 519
Pollister, A. W., The Amphibian Leucocyte, 390
Polydactylism in Mice, J. M. Murray, 312
Popular Science Monthly, Award of Medal, 260
Populations and Evolution, J. Stanley, 49
Porto Rico, University and the Dept. of Agriculture, 97
Potato Sprouts, O. H. Elmer, 193
Potzger, J. E., Succession of Forests, 366
Prehistoric, Research, Amer. School of, 279; Mounds in Florida, J. C. Gifford and A. H. Gilbert, 313
Psittacosis in California, 302
Publication, What is a?, T. I. Storer, 486

Race Competition, Effects of, S. J. Holmes, 201
Radiations, Natural, W. C. Broadfoot, 334
Radiosensitiveness of Cells and Tissues, A. U. Desjardins, 569
Rakestraw, N. W., Phosphate, Nitrate and Nitrite in Sea-Water, 417
Reading Knowledge, L. G. Romell, 515
Rees, C. W., Transmission of Anaplasmosis, 318
Regeneration in Bryophyllum, J. A. Yarborough, 84
Research, Scientific, in the South, G. J. Fertig, 595
Respiration, Apparatus for Determination of CO_2 and O_2 of, M. H. Haller and D. H. Rose, 439
Revillagigedo Archipelago, Expedition to, 352
Reyniers, J. A., Apparatus for Water Samples, 83
Rice, Chemical Composition of, J. Davidson and C. E. Chambliss, 294
Richards, G., Growth of Stalactites, 50
Richards, O. W., Photomicrography, 107
Richmond, B. G., Canker of the American Elm, 110
Richtmyer, F. K., The Romance of the Next Decimal Place, 1
"Rickettsia" and "Symbionts," I. J. Kligler and M. Ashner, 133
Ritt, J. F., Thomas H. Gronwall, 657
Rivers, T. M., Viruses, 654
Roller, D., Supervision of Student Research, 285
Romanoff, A. L., Multiple Laboratory Incubator, 246
Romell, L. G., Reading Knowledge, 515
Roos, C. F., New Orleans Meeting of American Association, 141; Syracuse Meeting, 361, 408, 547; Executive Committee, of, 611
Roosevelt the Naturalist, C. H. Merriam, 181
Rose, Wickliffe, S. Flexner, 504
Rosenberg, L. E., Culture Medium for Paramecium, 364
Royal Society, Medalists of the, 11
Rubinstein, H. S., Volume of Tissue, 389
Russell, R. J., Significance of Baer's Law, 584
Rydberg, P. A., Flora of Central North America, F. C. Gates, 667
Rygg, G. L., and C. M. Darrow, Inheritance in Fragaria, 269

Salivary Secretions and Microfilariae, C. F. Craig, 561
Salt Mixture, Osborne-Mendel, L. G. Wesson, 339
Schmidt, K. P., Museum Tags, 23
Schuchert, C., Glacial Control Theory Applied to Bermuda, 264
Science Service Conference, 492
Sciences, Natural, Present State of, A. Stock, 345
Scientific Assoc., Northwest, J. W. Hungate, 244
Scott, W. B., Expeditions to Patagonia, 607
Sea Cliff Recession, T. W. Vaughan, 250
Seashore, R. H., and I. N. McCollom, Studies in Motor and Mechanical Skills, 358
Sea-water, Phosphate, Nitrate and Nitrite in, N. W. Rakestraw, 417
Sedimentation and Sedimentology, H. Wadell, 20
Seifried, O., C. B. Cain and H. Wulf, Holder for Chickens and Other Birds, 315
Seismograph, Suspended Mirror, B. A. Wooten, 82
Semple, Ellen Churchill, W. W. Atwood, 657
Serial Dilution Method, A. P. Krueger, 494
Serum Albumin and Serum Globulins, A. Fischer, 443
Sex, Differences, V. C. Smith, 55; Antagonistic Substance in Urine, C. Funk and P. P. Zefirow, 564
Shark, Whale, Fifth Florida, E. W. Gudger, 412; on Coast of Borneo, A. W. Herre, 413
Shaw, F. W., Pathogenicity of Neisseria sicca, 488

Sheehy, E. J., Prevention of Convulsions, 81
Shrewsbury, C. L., and H. R. Kraybill, Vitamin A, 86
Sigma Xi, Princeton, 407; Western Reserve, 507; Illinois College of Medicine, 556
Singer, E., Microscope for Observation of Fluorescence in Living Tissues, 289
Skills, Motor and Mechanical, R. H. Seashore and I. N. McCollom, 358
Skull Bones, Disarticulation of, I. A. Wiles, 516
Smith, N. R., Air Filtration, 199
Smith, R. C., Upsetting the Balance of Nature, 649
Smith, V. C., Sex Differences, 55
Smith, W. C., and A. K. Wells, Petrographic Classification, 219
Smithsonian Expeditions, 601
Snakes, Visual Purple in, G. L. Walls, 467
Snow, Conical, W. A. Bentley (The late), 383
Snyder, V., John Wesley Young, 554
Soil, Research, Macauley Institute for, 375; Weights, L. B. Olmstead and H. G. Byers, 672
Solar, Eclipse, British Expedition to Canada, 577; and Radio Periodicities, C. G. Abbot, 607
Sollmann, T., Samuel Mather, 71
Soskin, S., Pancreatectomy in the Dog, 382
Spirochetes, Caecal, M. B. Harris, 498
Sponges, Living Fresh-water, J. T. Penney, 341
Spontaneous Combustion, P. Viosca, Jr., 461
Stalactites, Growth of, G. Richards, 50; and Stalagmites, K. Ver Steeg, 217
Standards, Assoc. International, Conference, 578
Standley, P. C., Pine Forests of Costa Rica, 437
Stanley, J., Evolution and Populations, 49; Livingston Atmometer Bulbs, 644
Stern, A. W., Magnetism and Electricity, 195
Stevens, N. E., Botanical Publication, 499
Stiles, C. W., Teaching Public Health Zoology, 664
Stock, A., State of the Natural Sciences, 345
Stockwell, P., Embedding Soft Material, 291
Storer, T. I., What is a Publication?, 486
"Strath" as a Geomorphic Term, W. H. Bucher, 130
Stratigraphy of Porto Rico, H. A. Meyerhoff, 342
Student Research, Supervision of, D. Roller, 285
Swann, W. F. G., Reality in Physics, 113

Tait, W. D., Behaviorism in Science, 462
Taliaferro, W. H., Blood-inhabiting Protozoa, 619
Tapeworm, Larval, Immunity to Infection, H. M. Miller, Jr., and M. L. Gardiner, 270; Broad Fish, W. P. N. Canavan, 337
Tarr, W. A., Meteorites in Sedimentary Rocks, 17; Granites and Rhyolites, 265
Taste Blindness, P. Levine and A. S. Anderson, 497
Tatum, A. L., and G. A. Cooper, An Antisyphilitic Agent, 541
Taxonomy, M. A. Fenton and C. L. Fenton, 608
Taylor, E. L., Epizootiology, 288
Tennessee Academy of Science, J. T. McGill, 669
Texas Academy of Science, H. B. Parks, 81
Thallium Poisoning, and Soil Fertility, S. C. Brooks, 105; M. W. Lyon, Jr., 381
Thermophil Nitrite Former, E. G. Campbell, 23
Thompson, Elizabeth, Science Fund, Awards, 353
Thomson, E., The Mosquito Population, 78
Tiedjens, V. A., Growing Cotton with Ammonium Nitrogen, 648
Tissue, Determining Volume, H. S. Rubinstein, 389
Toad Poisons, H. Jensen, 53
Tolman, R. C., Models of the Physical Universe, 367
Tottingham, W. E., Leaf Lipides, 223
Toumey, James William, H. S. Graves, 575
Townsend, C. H., Respite for the Whale, 288
Travis, L. E., and T. A. Hunter, Action Currents, 220; Analysis of Electromyograms, 639
Trees, Illuminating Gas and, C. G. Deuber, 496
Trichinae, Adult, in Rats, O. R. McCoy, 364
Trichromatic Functions of the Eye, W. F. Hamilton and E. Freeman, 292
Troglodytella, Cultivation of, E. C. Nelson, 317
Trumpler, R. J., Deflection of Light in the Sun's Gravitational Field, 538
Tubercle Bacillus, Staining Techniques, E. G. Alexander, 197; Misnamed Cultures, E. G. Hastings and J. McCarter, 513
Tumors, Inhibitor for, J. B. Murphy and E. Sturm, 540
Turkey Buzzards, the Soaring of, G. S. Dodds, 437
Twisted, Trees, N. F. Howard, 132; Tree Trunks, B. B. Brues, 585
Twisting in Plants, E. G. Hastings, 16
Tyzzer, E. E., Avian Coccidiosis, 324

Universe, Expansion and Density of, 384

Vanterpool, T. C., Cultural Methods, 22
Vaughan, T. W., Sea Cliff Recession, 250
Ver Steeg, K., Stalactites and Stalagmites, 217
Viosca, P., Jr., Spontaneous Combustion, 461
Virginia Academy of Science, 508
Viruses, T. M. Rivers, 654
Vital Statistics, British, 10
Vitamin, A, D. H. Cook and J. Axtmayer, 85; C. L. Shrewsbury and H. R. Kraybill, 86; F. E. Chidester, 286; C, C. J. King and W. A. Waugh, 357; G, in Tomato Juice, R. G. Daggs and A. G. Eaton, 222
Voegtlin, C., and H. Kahler, Hydrogen-ion Concentration of the Tissues, 362

Wadell, H., Sedimentation and Sedimentology, 20
Walker, R. I., Chromosome Numbers in Ulmus, 107
Walls, G. L., Visual Purple in Snakes, 467
Ward, Robert DeCourcy, W. J. Humphreys, 183
Warren, E. R., Wood in Beaver Dams, 194
Washakie National Forest in Wyoming, 556
Washing, Corpuscles in Suspension, C. A. Lindbergh, 415; Microscopical Tissues, D. Medaris, 590
Washington Academy of Sciences, 304
Washington Award to W. D. Coolidge, 260
Water, Samples, Apparatus for, J. A. Reyniers, 83; the pH of, H. T. Byck, 224; Content and Oxygen Consumption, W. R. Duryee, 520
Way, E. F., Entoptic Colors, 81
Weather and Determinism, R. C. Miller, 413
Webster, L. T., Experimental Epidemiology, 446
Welsh, J. H., Animal Behavior, 591
Wesson, L. G., Osborne-Mendel Salt Mixture, 339
West Indies, Marine Expedition to, 376
Westchester Institute of Sciences, 186
Wever, E. G., and C. W. Bray, Kreezer and Darge on Auditory Action Currents, 267
Weyl, R., Theory of Groups and Quantum Mechanics, E. U. Condon, 586
Whale, Respite for, C. H. Townsend, 288
Whaling in Japanese Waters, M. L. Peelle, 666
Wheeler, J. L., Science Booklists, 20
Wildman, J. D., Separating Insects from Food, 268
Wiles, I. A., Disarticulation of Skull Bones, 516
Williams, R. J., L. Friedman and D. M. Woods, "Pure" and "Isoelectric" Gelatins, 199
Winslow, C.-E. A., Changing Bacteria, 121
Woods of the World, 658
Wooten, B. A., Suspended Mirror Seismograph, 82
Wright, W. H., "Line Contour," 180

Yale Univ., Professorships in Honor of Gibbs and Sumner, 98; Fellowship Awards in the Sciences, 432; School of Engineering, 603

Yancey, P. H., Academic Freedom in Spain, 415, 537
Yanovsky, E., E. K. Nelson and R. M. Kingsbury, Berries Rich in Calcium, 565
Yarborough, J. A., Regeneration in Bryophyllum, 84
Young, John Wesley, V. Snyder, 554

Zeleny, J., Rumbling and Luminous Clouds, 80
Zinsser, H., The Bacterial Life Cycle, 256
Zoological Sessions at the Summer Meeting of the Amer Assoc., 456; Society of London, 528
Zoology, Teaching Public Health, C. W. Stiles, 664

SCIENCE

VOL. 75 FRIDAY, JANUARY 1, 1932 No. 1931

American Association for the Advancement of Science:
- *The Romance of the Next Decimal Place:* PROFESSOR F. K. RICHTMYER 1
- *Research and Industrial Organic Chemistry:* PROFESSOR JAMES F. NORRIS 5

Scientific Events:
- *British Vital Statistics; The Thayer Ornithological Collection; Medalists of the Royal Society; Award of the Chandler Medal to Professor Conant* 10

Scientific Notes and News 13

Discussion:
- *Twisting in Lower Forms of Plants:* PROFESSOR E. G. HASTINGS. *Meteorites in Sedimentary Rocks?:* PROFESSOR W. A. TARR. *Possible Relation of Age at Sexual Maturity in Birds to Daily Period, Intensity and Wave-length of Light:* PROFESSOR T. H. BISSONNETTE. *"Entamoeba" Phallusiae:* PROFESSOR MAYNARD METCALF. *Naturally Deposited Eggs of the Myxinoidea:* PROFESSOR J. LEROY CONEL. *Sedimentation and Sedimentology:* H. WADELL 16

Reports:
- *Science Booklets from the American Association:* JOSEPH L. WHEELER 20

Scientific Apparatus and Laboratory Methods:
- *Cultural and Inoculation Methods with Tilletia Species:* PROFESSOR T. C. VANTERPOOL. *A Thermophil Nitrite Former:* EVA GALBREATH CAMPBELL. *Museum Tags of Chemical Proof Paper:* KARL P. SCHMIDT 22

Special Articles:
- *The Distribution of Extra-Galactic Nebulae:* DR. EDWIN P. HUBBLE. *The Hemoglobin Content of the Blood of the Hen: A Statistical Study of Influences and Relations:* DR. H. H. DUKES, DR. L. H. SCHWARTE and PROFESSOR A. E. BRANDT 24

Index to Volume 74 i

Science News 8

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THE ROMANCE OF THE NEXT DECIMAL PLACE[1]

By Professor F. K. RICHTMYER

CORNELL UNIVERSITY

IN the year 1896 the *Beiblätter zu den Annalen der Physik* devoted 1,032 pages to reviewing the literature of physics. In 1930 the corresponding journal required almost five times that amount of space.

The *Physical Review* for 1896 contained 490 pages of text. Computed on the basis of the same size and form of page, the *Physical Review* for 1930 contains over 5,000 pages—an increase of over tenfold.

At the present rate, graduate schools in America are granting ten times as many doctorates in physics as they did at the beginning of the century.

If we take into account the large amount of research in technical, industrial and governmental laboratories which is never published, and if we ignore the still larger amount of work in engineering which has grown directly out of physics and is published in engineering journals, we should probably be justified in making the statement, which I believe to be conservative, that there is now in progress from twenty to twenty-five times as much research in physics as there was a third of a century ago.

Physics in 1931, however, differs from the physics of, say, 1895 not only in volume of activity, great as that is to-day, but also in basic theories and viewpoint, as well as in underlying factual content. The physicist of 1895, in his wildest imagination, could not have dreamed of x-rays and radioactivity, each to be discovered within a year; of the quantum theory, to be proposed before the century ended; or of the rôle which the then hypothetical electron was to play not only in altering completely the whole framework of physical theory but in making possible inventions and other developments which were to revolutionize certain important phases of our economic and social life. Indeed we of to-day are so impressed with both the quantity and the fundamental nature of our contributions that we are wont to think, and even sometimes to remark, that the progress which physics has made since 1895 exceeds that of all preceding time.

But if we view our science objectively and in unbiased historical perspective we must conclude that this extravagant evaluation of the prowess of the twentieth century physicist is hardly justified. The generation of physicists immediately preceding ours likewise took giant strides. When silhouetted against historical background Maxwell's electromagnetic theory and its remarkable experimental confirmation by Hertz loomed up as large to the physicist of 1895 as the de Broglie-Schrödinger wave theory of matter and its experimental confirmation by Davison and Germer does to the physicist of to-day.

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[1] Address of the retiring vice-president of Section B—Physics, American Association for the Advancement of Science, New Orleans, December 30, 1931.

Stepping back another 30 years from 1865: With what pride must the older contemporaries of the young Maxwell have viewed such outstanding achievements of their generation as Faraday's discovery of electromagnetism. What could be more fundamental and far-reaching, even outside of physics proper, than the law of conservation of energy firmly established by the experiments of Joule in 1846? Had not one of their number, Foucault, with unsurpassed experimental skill, actually settled for all time the two-century-old conflict between the corpuscular and the wave theory of light by showing that light actually travels slower in water than in air?

And to all these claims of preeminence we can imagine the shades of the next older generation protesting: "Ah, but you forget that Joule was but completing Rumford's work begun in 1798; that the starting point of Faraday's researches was Oersted's discovery of the magnetic effect of an electric current (in 1819); that Young and Fresnel in the first two decades of the nineteenth century really established the wave theory of light, which was merely confirmed by Foucault's experiments."

If we trace this story still farther back we find that, except for the more or less sporadic contributions of the ancient and medieval world, the science of physics arose almost asymptotically out of comparative nothingness only a short time ago, at least as measured on the time scale used by the historian to mark the progress and development of human society. Whether we say that physics began with Galileo, or with Copernicus, or with Roger Bacon is relatively unimportant. Of great importance is that fact that since its beginning physics has increased, with each generation, in geometrical ratio. If there is anything remarkable in our twentieth century physics it is perhaps not so much because of the fundamental nature of the changes since 1900, as because of the number of those changes which have taken place in a single generation—a remark which has probably been made by each of the generations which has preceded us!

Now, what are the factors which have made this accelerated growth possible? Volumes have been written in attempts to answer this question for all science, as well as for each science in particular. It is generally agreed that it is no accident that the beginnings of modern science were contemporaneous with the discovery of the art of printing; and that the rate of growth of science has followed closely improvements in that art. When permanent records of the works and thoughts of one generation could be quickly and cheaply made, not only for ready exchange among the members of that generation but for passing on to the next, progress became possible.

Further, increased speed in the transmission of intelligence, both by development and improvement in systems of transportation and by such agencies as telegraphy, cable and telephone, have reacted to speed up scientific research. It is said that within forty-eight hours after American newspapers had printed the cable dispatch reporting the discovery of x-rays by Roentgen, at least six x-ray photographs had been made in laboratories on this side of the water. On the contrary, Henry did not learn of Faraday's experiments on electromagnetism until several months after the announcement was made in England.

Then, too, there is the reaction which has come from the application of science in so many aspects of modern life. The present great volume of scientific research is made possible in very large part because society believes such research is useful.

We must not forget, also, that, probably because of this demonstrated usefulness, the work of the scientist is no longer viewed with suspicion and intolerance. He is free, except for here and there a backward community, to hold such theories and to perform such experiments as he pleases. No longer need a Galileo abjure, nor a Roger Bacon spend half of his life in prison because he had made discoveries that proved to him that previous theories were untenable.

This freedom to experiment and to interpret the results of experiment has been a determining factor in the development of the so-called laboratory sciences. Observation merely of the phenomena in the world about us would be quite ineffective in advancing such a science as physics.

Now, broadly speaking, laboratory research in physics falls under two classifications. First, there is the pioneer work of exploration and of rough measurement as a result of which phenomena are discovered and classified. Second, there is the precise measurement and study of these phenomena in an attempt to set up physical relations as exact as the technique at hand may permit. It is this latter type of measurement which has given to physics the name "exact science"—an appellation which those of us who attempt to make so-called "precision" measurements know to be entirely unjustified! Otherwise expressed, we may say that the purpose of making such careful measurements is, to borrow Rowland's famous phrase, "to investigate the next decimal place."

Now why should one wish to make measurements with ever-increasing precision? Having measured the velocity of light to four significant figures, why should one wish to know what the next "decimal place" is? "Because making such measurements is great fun," the late Professor Michelson is said to have remarked. "Because only by making such measurements can we establish exact physical laws," will be another obvious answer. To these two answers I wish to add a third: "Because the whole history of physics proves that a new discovery is quite likely to be found lurking in the next decimal place." If the making of a new scientific discovery is thrilling to the discoverer, and if a romance is a human event which thrills the participants, then we may justly speak of the "romance of the next decimal place." To devise methods of making measurements with greater precision than has ever been attained before; not only to establish so-called exact laws, but possibly to discover new and unsuspected phenomena furnish both fun and thrills not surpassed by any other quest in scientific research.

A well-known industrial physicist once remarked that no physical measurement was worth making which required a precision in excess of one per cent. Let us examine a few typical cases to see what sort of structural members would be lacking from the framework of modern physics if investigators had been content with one per cent. as a limit of precision.

One of the most conspicuous examples of the importance of precise measurements is to be found very early in the history of physical science. In 1543 Copernicus revived the long-discarded heliocentric theory of the universe, postulating that the planets move round the sun in circular orbits. Possessing a qualitative rather than a quantitative background, the theory made slow headway. Had no further evidence been obtained, there is no *a priori* reason to believe that Copernicus would have been more successful in convincing a skeptical world than was his predecessor Aristarchus eighteen centuries earlier.

But then came Tycho, a man to whom, as to our own Michelson, the making of fine instruments and their utilization in research was "great fun." Further, Tycho's own theory of the universe, quite at variance with that of Copernicus, could be established only by observing the motions of the planets with much higher precision than had yet been attained.

And so Tycho began to investigate the "next decimal place." After twenty-five years of the most painstaking devotion to the design and use of his instruments he had accumulated a series of observations on planetary motion not only by far the best in existence at the time but still regarded with wonder and admiration when we consider the crudeness of his apparatus as compared with our own. It is said that in the delirium of his death-bed Tycho prayed that his life might not have proven useless. We can well imagine that his prayer arose from a realization that his life work consisted only in a mass of observations and that he had failed to prove his theory of the structure of the universe. What would posterity think of him for having done nothing but observe?

Such questions are still asked to-day. Not only men of the town but not a few of even those of the gown are wont to belittle the endeavors of those whom they call "hair-splitting scientists," who devote their lives merely to devising and to using instruments and methods intended to make four significant figures grow where only three grew before.

How completely was Tycho's prayer answered during the century following his death (1601)! Kepler's use of Tycho's data is too well known to require extensive comment. After years of the most intensive study Kepler finally found that the hypothesis of circular motion as applied to the planet Mars was inconsistent with Tycho's observations, there being at certain points in the orbit of Mars a discrepancy between the predicted and observed position of as much as eight minutes of arc—the angle subtended by the lead of an ordinary lead pencil at some twenty feet!

Accordingly, Kepler rejected the principle of circular motion, a principle assumed by Copernicus and held unquestioned for 2,000 years. After various trials and failures, he was finally led to try an ellipse. By placing the sun at one focus, Tycho's observations were satisfied. Conjecture as to the nature of the planets' paths had given way to proof that the paths of the planets were ellipses. A most important law of planetary motion had thus been discovered. "These 8 minutes (of arc) alone," Kepler later wrote, "have led the way towards the complete reformation of astronomy."

But not only astronomy! One may trace a direct path from Kepler's proof of the elliptical nature of the planetary orbits to Newton's proposal and ultimate proof of the inverse square law of gravitation. Thus Tycho's study of the next decimal place had not only led to the acceptance of the Copernican theory of a heliocentric world, but had influenced most profoundly both physics and philosophy. For, without such careful measurements, the true paths of the planets must ever have been a source of conjecture, confirmation that the law of gravitation extends at least to the boundaries of the solar system would have been wanting, and man would not have been able to envision a universe governed by immutable laws.

The century which followed Newton did not see much attention paid to the making of precise measurements, at least by physicists. Nor, in turn, were there many significant advances recorded. It may be not without point, however, to make mention of the fact that Newton's failure to investigate the next decimal place, in his study of the relation between index of refraction and dispersion, led him to the erroneous conclusion that these two quantities are proportional and that therefore achromatic optical systems are impossible, an error which persisted for many decades.

It is generally agreed that the first two or three decades of the nineteenth century mark the beginning of a new era in the history of physics, in that during this brief period there were introduced basic concepts as to the nature of light, heat, electricity and magnetism which provide the foundations of so much of modern science. It is by no means a mere coincidence that this period saw also the general recognition of the important part which precise measurements were to play in the development of physical theory. Thus, Young's discovery of the interference of light, although not technically "in the next decimal place," was essentially the result of precise adjustment of apparatus and of careful observation. In this class also falls Faraday's discovery of electromagnetic induction, since his observance and interpretation of the minute deflection of his galvanometer led the way to further study and to the establishment of the laws of electromagnetism. Rumford's qualitative theory of the nature of heat was no more convincing than was Aristotle's theory of the solar system. But when Joule actually proved that 772 foot pounds of mechanical energy are required to raise the temperature of one pound of water one degree Fahrenheit the quantitative relation thus established provided an argument as cogent as were Kepler's elliptical orbits.

Indeed, one outstanding characteristic of nineteenth century physics is the extent to which the making of precise measurements, *merely for the sake of securing data of greater accuracy,* became a recognized part of research in physical laboratories. This point is aptly illustrated by Lord Rayleigh's determinations of the absolute density of gases in the early nineties.

Proust's law demanded that the ratio of the respective densities of oxygen and hydrogen should be 16 : 1. The measurements of this ratio by Regnault as early as 1845 yielded 15.96 : 1, a result in agreement with Proust's law almost within experimental error. In 1888 Rayleigh attacked the problem anew, and, after a long investigation described by him as "unusually tedious," found that the ratio was 15.882 : 1, thus proving untenable the theoretical value of 16 : 1.

Having thus developed an improved technique for measuring the density of gases with great accuracy, Rayleigh, for no apparent purpose other than to satisfy his curiosity, decided "before leaving the subject (to ascertain) not merely the relative but also the absolute densities of the more important gases." In the course of this investigation he found that nitrogen, prepared from its chemical compounds and thus presumably pure, had a density of 1.2505 grams per liter, while that prepared by removing oxygen from ordinary air had a density of 1.2572 grams per liter, a difference of about ½ per cent. which previous and less precise determinations had failed to detect. After eliminating one by one the various possible sources of contamination with known gases, Rayleigh concluded that the difference in density must be due to the presence in the atmosphere of a hitherto unknown gas more dense than nitrogen. This clue led Rayleigh, in collaboration with Ramsay, directly to the discovery of argon. Subsequently the whole series of noble gases was discovered.

Seldom has a discovery been more fruitful. Occupying, as they do, unique positions in the series of the elements, these noble gases may be said to provide the very foundation stones for that elaborate and beautiful edifice which we call "atomic structure." The use of helium, neon and argon for so-called practical purposes is commonplace. Whereas Rayleigh with great difficulty prepared a few cubic centimeters of argon in 1894, to-day that gas is produced in large quantities for commercial purposes. "Bigger and better" dirigibles are made possible through the use of helium. Even the legal profession is reaping a rich harvest from the crop which grows out of Rayleigh's fifth significant figure, for it is said that more than a million dollars has been spent in litigation over the neon-sign patents!

That last decade of the nineteenth century, one of the most fruitful and romantic in the whole history of physics, provides a close parallel to the discoveries of Tycho and Kepler. For, just as the century was closing Planck, analyzing the data of Lummer and Pringsheim on temperature radiation, announced the quantum theory, which was destined to revolutionize the whole trend of physics and, though perhaps to a lesser extent immediately, of philosophy. Just as Tycho's observations agreed with the theory of circular orbits except for certain small differences in parts of the orbit, so the data of Lummer and Pringsheim agreed with Wien's law of temperature radiation, except for certain small discrepancies at long wavelengths. In both cases the theorist, placing confidence in the accuracy of the observations, was led to propose a new and a very fundamental theory.

This principle of the importance of the next decimal place, in leading to new discoveries is, though perhaps unconsciously, given recognition in the fact that one expressed purpose underlying so much of our modern research in physics is to increase the precision with which physical phenomena may be observed. For 25 years attempts to observe the refraction of x-rays failed. About 1920 Siegbahn and Larsson, pushing measurements of wave-lengths of x-rays to higher and higher precision, found that the wave-length of Cu Ka radiation, as measured in first order reflection from a mica crystal, differed from similar measurements in the eleventh order by about 0.15 per cent. They correctly attributed this difference to refraction of the rays as they entered the crystal, a phenomenon hitherto unobserved. To-day indices of refraction for x-rays (strictly speaking, the difference between the index and unity) are measurable with a precision in excess of 1 per cent. Until a few years ago no one had succeeded in producing an x-ray spectrum by reflection from a ruled grating. Recently, by use of such a grating, Bearden has reported measurements of x-ray wave-lengths with an estimated probable error of 0.01 per cent. As is well known, the slight discrepancy between the values so obtained and those yielded by use of a crystal grating has necessitated a critical reexamination of the whole technique of x-ray spectroscopy, and perhaps requires some fundamental modifications in our concepts of crystal structure.

In 1900 Drude, in his "Theory of Optics," remarked that "this (radiation) pressure is so small that it can not be detected experimentally." Almost before Drude's book was released from the press, Lebedew in Europe announced the experimental discovery and rough measurement of this phenomenon; and within three years Nichols and Hall in America reported measurements of radiation pressure with an estimated probable error of about one quarter of 1 per cent. The bearing of these measurements on theories of radiation is too well known to need comment.

In a little over a decade, Thomson's apparatus for studying positive rays evolves into Aston's precision mass-spectrograph, in which the relative masses of atoms can be measured with a precision of the order of one part in 10,000. After observing the "fine structure" of spectral lines the spectroscopist goes on to observe "hyperfine structure." A recently reported critical examination of existing data leads to the conclusion that the most probable value of "e," the charge carried by the electron, is 4.7721×10^{-10} as e.s.u. instead of 4.774×10^{-10} as previously used. From each such extension of the precision of measurement there results either a significant modification of theory, or not infrequently a new discovery. So frequently has this happened in the history of physics that to sum up what I have said I am disposed to conclude by paraphrasing a famous saying: "Look after the next decimal place and physical theories will take care of themselves."

RESEARCH AND INDUSTRIAL ORGANIC CHEMISTRY[1]

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I EXAMINED a short time ago the advertisements in a copy of *Industrial and Engineering Chemistry* to see to what extent the pages reflected the recent development in this country of industrial organic chemistry. I found 42 organic compounds advertised which are available for large scale use. Many of these are new substances; the rest have been used but are produced now at lower prices and in a purer condition than in the past as the result of the application of new synthetic methods. In the list were several compounds of importance on account of their use as intermediates in the preparation of a great variety of technical products. A study of the methods by which these results have been reached shows clearly that chemical research of a high order is the foundation upon which the achievements rest. A broader survey of the present condition of the organic chemical industry leads to the same conclusion.

The division of engineering and industrial research of the National Research Council has as one of its important activities the study of the relation between research and industry and has demonstrated in its publications the controlling significance of this relation.

The chemical industry of the United States has grown rapidly since the world war. It stands high in the list of industries arranged according to the number of men employed, returns and capital invested; it is thus an important factor in the economics and well-being of the country. I shall limit myself in this address, however, to organic chemistry, the field in which my knowledge and chief interest lie.

The supply of many important chemical compounds used in a variety of industries was suddenly cut off when the country entered the recent war. It was

[1] Address of the retiring vice-president and chairman of Section C—Chemistry—American Association for the Advancement of Science, New Orleans, December, 1931.

necessary to manufacture without any background of experience a great variety of substances, such as dyes, pharmaceuticals, etc. The methods used in the preparation of these substances were in many cases protected by patents owned by foreign corporations. Under the circumstances the United States Government took over such patents and provided a way to make possible the manufacture of these essential materials. In order to put the patented processes into operation it was found necessary to carry out a large amount of research based on the scanty and more or less indefinite disclosures in the patents. This procedure was costly but yielded the desired results. Most important of all was the conclusion that research is a factor of prime importance in industry. The learning of this lesson by the executives of corporations who dictated policies and expenditures proceeded slowly at first, but after the results became more and more evident the conservatives were finally convinced.

I had an excellent opportunity in 1924–1925, as chairman of the division of chemistry and chemical technology of the National Research Council, to study the relation between research and the organic chemical industries. The investigation brought out the fact that certain great industries were not utilizing chemical research adequately. An attempt was made by the division to bring about cooperative research in certain industries. The response by executives was not, at first, encouraging. The president of a large petroleum company told me it was not the business of the chemist to meddle in the affairs of the industry. His company had millions of dollars invested in plants. It was satisfied with the results. He did not want anybody to do anything to make these plants obsolete.

A high executive in another industry told me he did not believe it good business to spend money on research to develop new products or methods. He had found it better to let some one else bear the expense of such work, most of which proved of no value. If anything worth while came out of it he could afford to buy it. What a change has come about in seven years. The two industries to which I have just referred are now spending millions of dollars in research.

The financial depression has had little influence on the research activities in chemical industries. Statistics gathered by the American Chemical Society show that few trained research men have lost their positions. One of the progressive organizations had more men on this type of work this summer than ever in the past.

A careful study of the factors involved in the relationship between research and industry is leading to a fuller appreciation of the value of results that follow the use of research as an industrial tool. At this time I shall refer to but two of these factors. The first and most important is the attitude of the executives. I have already said that this is improving, but much remains to be done. It was not long ago that the consolidation of several chemical industries into a large corporation promptly resulted in the abandonment of research and the discharge of the men who were advancing the industries involved. It was also not long ago that a chemist from Switzerland, who was well informed as to the condition of industry in his own country and in Germany, pointed out the handicap under which certain American industries function as the result of being under the control of men ignorant of chemistry. These conditions also are changing. I once expressed to a friend, who had been successful in the direction of the research of a corporation, my regret from the standpoint of science that he had been transferred to an executive position. He showed me that my attitude was wrong. In the new position he could influence the directors of the corporation to adopt a more liberal and better understanding policy in regard to research.

Some of the most brilliant industrial developments in organic chemistry have been the result of research that required from five to ten years to reach the goal. Methanol and gasoline synthesized from coal have been the reward of long-continued endeavor. It required the foresight of one who knows what research can do to enter upon such a long chase. As each success is achieved the way for future development becomes easier.

The winning of the confidence of executives in the money value of research is proceeding rapidly. It is reassuring that a large number of chemical industries has contributed annually to the American Chemical Society a substantial sum to help in the publication of *Chemical Abstracts*. Appreciation of the work done in preparing men for research in chemistry is shown by the fact that over thirty students are financed by chemical industries at Johns Hopkins University. One large corporation maintains fellowships in chemistry at about twenty educational institutions. The men receiving the aid are not restricted in regard to the subject of their researches. There is a large number of fellowships of a different type established in colleges and universities. In these the research problems are closely allied to the industries which support them. The object in these cases appears to be more the results hoped for than the training of research workers.

The increased use of research in chemical industry has resulted in the rapid growth of centralized research organizations. Under certain conditions it has been found better to use the broad background of experience of these organizations and the services of their skilful research men rather than to place the problem in a laboratory closely associated with plant operation.

The division of engineering and industrial research has done good work in helping to bring to the attention of executives of corporations the work of industrial research laboratories. The division organized and conducted two tours of inspection for executives through the laboratories of a large number of industries. It is planned to extend this service to the research organizations of Europe.

The second most important factor in the development of industry by research is, in my opinion, the personnel of the laboratories. This factor is of particular interest to those who have the responsibility of assisting in the education of research chemists. Much study of the problem involved in training minds is being carried out outside the schools of pedagogy. The American Council of Education has been endeavoring to formulate what qualities and qualifications professional scientists should possess. One of its studies has been devoted to organic research chemists. A teacher interested in helping to build an individual as near the ideal as possible sees that he can help in ways apart from the use of the old-fashioned formulas of his profession.

In recent years the methods and personnel of the industrial research laboratories have changed rapidly. The empirical approach to the solution of a problem has largely disappeared and has been replaced by coordinated investigation carried out with the use of the scientific methods and with a knowledge of the latest findings and instruments of fundamental science. The industrial laboratories keep informed as to the new knowledge resulting from research in the universities. Requests are received from such laboratories for reprints of papers which apparently are only of theoretical interest.

The change in the industrial laboratories has come about as the result of a change in personnel. I was consulted several years ago in regard to the appointment of a director of a proposed research laboratory for a chemical industry, which was conducted largely by rule-of-thumb methods. The directors insisted on the appointment of a well-informed organic chemist, preferably a university professor, who had no experience in the industry which he was expected to develop. In this case there was good judgment in the point of view.

Opportunities are rapidly decreasing for the advancement in his profession of the chemist whose scholastic experience is limited to a four years' course leading to the degree of bachelor of science. To get ahead he must put chemistry behind him and become a manager or executive. The men to-day who are developing the industry are some of the best of those who have learned the methods of research in winning the doctor's degree. It may be profitable to digress at this point to consider some of the effects of this change. For those of us who are training these men it is necessary to know what experience has shown to be the best type of preparation for this work.

The scientific background of the organic chemist of thirty years ago was largely limited to a knowledge of the properties and chemical behavior of the substances with which he had to deal. He used the physico-chemical concept of molecular weight and the laws relating to the effect of solutes on the freezing and boiling points of solutions. He was prepared to undertake the study of the structure and the synthesis of organic molecules—the major problems of the time.

The advances made in physics and physical chemistry have furnished the organic chemist with new fundamental concepts, methods and tools, which have been applied with astounding success; and other possible aids of this sort are now waiting to be used in the study and control of organic molecules. The application of thermodynamics, thermochemistry, the laws of vapor pressure, rates of reaction and their temperature coefficients, the concepts of free energy, chemical equilibrium and ionization, catalysis, x-rays, and different types of energy with varying intensity factors—these and other important facts and generalizations have broadened the methods of research in organic chemistry, and have been applied in the solution of industrial problems.

For the research chemist who enters the industrial field a knowledge is important of the principles of chemical engineering which follow from the application of those laws of physics and physical chemistry which have to do with the physical relationships between molecules.

Those who direct the education of students of organic chemistry should see to it that the preparation for future work includes training in the principles of physical chemistry and their use. It was not so long ago that one of the leading universities of the country had no requirement in physical chemistry for men awarded the doctorate in organic chemistry. Happily, conditions are improving.

The growth of the use of research in the industries based on chemistry is indicated by the rapid increase in the number of men awarded the degree of doctor of philosophy in American universities. A compilation made by the National Research Council shows that much the larger number of these degrees is in the field of chemistry. Many of the young men awarded this degree have entered industrial research laboratories, where they are happily at work on problems of great interst, are supplied with every facility and are in a congenial scientific atmosphere. Their value is clear from the compensation they receive.

The business world, apart from the industries themselves, is learning the importance of research. Some of the more progressive and larger banks seek information and advice before investments in or loans to certain corporations are made. The banker wants to know what percentage of profits is expended in research, something of the personnel and aim of the laboratory, the extent to which there is diversification in the products manufactured and the future possibilities of new ventures. Great financial loss has resulted from investments made without the judgment of well-informed experts.

There is time to make a brief survey of a few of the achievements of industrial organic research in this country, as examples of the application of the more recently applied methods of investigation. The substances considered can be conveniently grouped according to the causes which led to their investigation.

A constant aim of the manufacturer is to reduce cost. The cost of a material which is necessary in the production of a new and useful product determines whether or not the product is made and used. There are now a number of substances possessing properties that would lead to their extensive use if the cost of the intermediates required in their manufacture could be reduced a few cents per pound. Potentially large industries are waiting such reduction.

The production of certain aliphatic acids has been studied from this point of view. The price of acetic acid, which is so extensively used, is yielding to the effects of research. The search for new methods of preparation, rather than the improvement of the old, has yielded a process from calcium carbide made from coal and another based on the catalytic oxidation of alcohol by air. It is stated that with the use of alcohol the cost of the acid can be reduced to a surprisingly low figure. A search is now being made for cheap propionic acid. Success will depend on the use of a very cheap material for the source of the carbon atoms.

Several amyl alcohols prepared from the pentanes in petroleum are now available. The investigation necessary for the successful industrial use of the reactions involved required much time and skilful effort.

The modern method of preparing alcohol free from water for industrial use is a striking example of the application of the principles underlying the vapor pressure of two and three component systems.

The industrial preparation of esters, as illustrated in the case of ethyl acetate, brings out clearly how physico-chemical principles and chemical engineering solved in a very neat way a problem of organic chemistry.

A new process has recently been announced for the preparation of higher aliphatic acids and alcohols from fats as the result of reduction by hydrogen under pressure. The results in all the cases cited were produced by modern research methods. It would lead too far to amplify this statement. A consideration of the development of our knowledge as the result of the study of the chemical behavior of molecules under high pressures and at high temperatures would be of value only if furnished by a specialist in this field.

Two important aromatic intermediates, phenol and aniline, are now produced from chlorobenzene by new processes, which in the light of the older organic chemistry seemed well-nigh impossible. But the application of the newer knowledge and methods yielded a solution of the problem.

The use of waste materials and by-products to prepare valuable substances has always been a fascinating field of endeavor to the chemist. It is only recently that outstanding results have been obtained. The wastes from oats, cottonseed and corn-stalks are now converted into chemical compounds of value.

The gases produced in the cracking of petroleum in the preparation of gasoline, until recently, were of value only as a source of heat. Years have been spent in the study of the conversion of the unsaturated hydrocarbons contained in these gases into alcohols. An application of a knowledge of the influence of the structure of hydrocarbons on the rates at which they react with sulphuric acid of varying concentrations, converted an empirical and unsatisfactory process into one that yielded purer products and compounds not obtainable by the older method. Tertiary butyl alcohol was changed from an expensive research chemical to one that can be sold in carload lots at a low price.

A third driving force behind industrial organic research is the desire to prepare substances that possess the particular physical properties required for a specific use. The change from paint to lacquers in the automobile industry brought forward the problem of solvents which led to much research in their use and their preparation.

Artificial silk and plastics have kept chemists at work for years. It is probable that new developments will soon appear. The thorough study of certain types of condensation reactions and the relation between physical properties and the length of the carbon chain in products formed by condensation have led to the production of compounds which may become important factors in the textile industry.

Synthetic rubber has lost most of its industrial significance, but fundamental research carried out by industry on the process of polymerization has led to the preparation of a product that will probably replace rubber in certain of its uses. The new material possesses properties that are superior to those of rubber from the standpoint of these uses.

The extensive development of ethylene glycol and its derivatives has added a number of compounds to the products that have found, or are waiting to find, industrial uses. The recent great expansion of the use of cellophane, after the substance had been known so long, must give hope to those who have spent much time in the development of substances that have not yet found their place.

I have but mentioned a very few of the substances that are worthy of note in a review of the part played by research in the organic chemical industry. These were chosen as examples to show to what extent research of the highest type was used. The chemist familiar with the steps by which the results were achieved is impressed by the methods by which they have been reached.

When one has reviewed the past and has endeavored to relate the causes with the results obtained, it is a pleasant mental diversion to look into the future and try to sketch the flow of events. Zest is added to this play of the imagination if an attempt is made to find new causes and new conditions that would probably lead to accelerated progress.

It is easy to see important future developments resulting from the application of known knowledge in the study of industrial problems. These developments are assured. But much lies ahead awaiting the accumulation of yet undiscovered facts and principles to be applied. As I have already indicated, industrial research chemists are using effectively the results of "pure" research, but advance is impeded by a lack of more detailed knowledge of the molecules themselves with which they are busy. Past studies have been devoted largely to the investigation of the interaction between molecules; and from the results obtained conclusions have been drawn as to the arrangement of the atoms in the molecule. The theory of structure has led to great triumphs in synthesis, but the graphic formulas we use tell us nothing of the molecules except a probable arrangement of their constituent atoms. A wide background of facts not indicated in a formula must be used in interpreting the significance of the structural relationships represented.

We know but little of how the atoms in a molecule are held together and how different atoms in relatively different positions affect the so-called bonds between the atoms, which we represent as straight lines or by two dots. I recall a statement made by Professor Remsen when he was lecturing to his students on double salts. He wrote the formula of such a salt, in the way used then, with a period between the two simple salts from which it was prepared. He pointed to the period and said, "Gentlemen, that period has been a full stop to thought." For years the lines written between atoms in a structural formula satisfied organic chemists. Lately two dots have replaced the line in an attempt to make use of the concept of electrons. I fear to some the change is satisfactory and the history of the line will be repeated.

Organic chemists should learn a lesson from the physicists. One can not use too strong or flamboyant words in expressing an appreciation of the results of ten years' intensive study of atoms. What has been accomplished has opened new roads that lead to the very heart of the atom. A similar fruitful field lies before the organic chemist in his molecules. The problem may be harder or it may be easier in some of its aspects, but it is certain that it warrants study and that the results will be repaying.

How is this new knowledge to be gained by which organic chemistry will be changed slowly from a science largely empirical to one based on principles? Is the way followed to-day the best? To what extent can the industries themselves help? In the applications of electricity, practice is working at the borderland between the known and the unknown, and the industry in its laboratories is pushing the boundary farther ahead. Have we a right to hope that those who control the policies of the research laboratories of the organic chemical industries will make possible a search for the fundamental principles underlying these industries? There has been a start in this direction, but the strong pressure toward the immediately practical application is hard to resist.

The kind of study that I have in mind is costly, and the results come slowly. How best can it be accomplished? Organization based on cooperative effort appears to be one solution of the problem. We have seen, since the war, cooperation between government and industry in Great Britain. Extensive laboratories supported by public funds and by contributions from the more important industries have yielded results which are the common property of those who have cooperated. The canners in the United States support a laboratory that has been a great success.

The method has many evident advantages and has demonstrated the value of cooperation. As far as I am informed the laboratories have been busy, almost exclusively, with practical problems. It would be a long step ahead if industry would undertake in the same spirit more fundamental investigation.

Let me present one illustration of what might be done. In 1929 over 300,000,000 barrels of crude petroleum were converted, in the United States, into commercial products by processes that involved chemical changes in the constituents of the crude oils, which differed widely in composition. The methods used in the "cracking" processes employed are based on empirical knowledge. Very little is known as to the behavior of the many individual substances, largely of unknown composition, in the complex mixtures used. If the several organizations in the industry would contribute in a cooperative spirit to the support of a laboratory to study fundamentally the molecules of hydrocarbons, the results in time would, without doubt, be of the greatest value. As little as one cent for each ten barrels cracked would yield at least $300,000 annually for such work. It is my opinion that the organization and the research program for such a laboratory could be worked out in a way to ensure successful operation. No attention should be paid to immediate applications of the results of the work, and publication of these results should be unrestricted. The utilization of the findings of the laboratory in developing processes should be undertaken by the cooperating contributors to the enterprise. A part of the available funds could be used in supporting those researches in university laboratories that had to do with aspects of the fundamental problems of the industry.

I have outlined earlier in this address the broadening of the view in regard to research of the men who control the finances of great corporations. The next advance will come when these executives learn to appreciate the dependence of applied science on "pure" science to such a degree that they will see the value of devoting a fraction of earnings—even an almost infinitesimally small fraction—to the support of the "goose that lays the golden egg."

I shall never forget a prophecy made by Elihu Thomson in an address on the electron before the American Academy of Arts and Sciences. He told the little that was known at the time of this constituent of atoms. Foreseeing the possibilities lying in this sub-atomic entity he boldly prophesied that within a few years electrical engineering would be transformed into electron engineering. The prophecy has come true and the lesson to be drawn from it is evident.

The study of the present status of industrial organic chemistry leads to the conclusion that the development of the industry is based on research in which the results of "pure" science has been applied with great success. A stage has been reached which emphasizes the need of a more fundamental knowledge of the chemical units—the molecules—which are used in building up the valuable substances produced by the industry.

SCIENTIFIC EVENTS

BRITISH VITAL STATISTICS

THE registrar-general's "Statistical Review of England and Wales for 1930," according to a summary in *The British Medical Journal,* contains statistics of population, births, marriages and divorces, registers of electors and vital statistics of the British Dominions. A table is given showing the populations of England and Wales, Scotland and Ireland as enumerated at each census from 1821 to 1921, and so estimated for each year 1891 to 1930 inclusive. The number of marriages solemnized in England and Wales during the year 1930 was 315,109, against 313,316 in the previous year. The rate in both years was 15.8 persons married per 1,000 persons living. This rate is the highest recorded since 1921, notwithstanding the present economic depression. Of the total marriages 31 per cent. were solemnized during the third quarter, or more than double the number during the March quarter. This preference for the third quarter has been constant since the beginning of the present century, prior to which the fourth quarter had been the favorite quarter for marriage. It is interesting to observe that 22 males and 699 females married at 16 years of age, the lowest legal age at which marriages may be solemnized, and that while the 22 males married females up to 23 years of age, the 699 females married males of varying ages between 16 and 49 years of age; in only five cases were the bride and bridegroom of the same age. The number of decrees nisi made absolute in respect of dissolution or annulment of marriage was 3,563, an increase of 167 over the figure for the preceding year. The births registered during the year totalled 648,811, an increase of 5,138, though the rate of 16.3 per 1,000 of the population remained the same. This increase in the number of births is probably in consequence of the high marriage rates recorded during the last two years. The proportion of the sexes in the births registered during the year was 1,044 males to 1,000 females, thus continuing the approximate proportion of recent years. There was at the end of the year 1930 a total of 157,948,940 names in the registrar-general's index available to the general public for searches in the registers of births, marriages and deaths. The statistics relating to parliamentary electors give the figures for the 1930 register for England and Wales as 12,101,108 males and 13,629,399 females, making a total of 25,730,507 electors, with increases of 234,314 and 400,400 in the respective sexes over the preceding year.

THE THAYER ORNITHOLOGICAL COLLECTION

WHAT is perhaps the finest private collection of North American birds, nests and eggs has been given to the Museum of Comparative Zoology at Harvard by the owner and collector, John Eliot Thayer, of the class of 1885. The collection, numbering about 30,000 skins and many thousand sets of nests and eggs, includes almost all the rarest North American birds and their eggs.

Mr. Thayer has sent out many carefully planned expeditions in an effort to secure rare specimens. His parties have visited Alaska, northeastern Siberia, the Queen Charlotte Islands, Lower California and northern Mexico. In Alaska one of his parties discovered the nesting place and secured the only surf bird's eggs known to be in any collection.

The bird skins in this collection are said to be beautifully prepared by the most expert taxidermists. One of the examples of this work is an adult male Labrador duck, a species extinct for sixty to seventy-five years. The Thayer specimen, formerly in the collection of Lord Derby, of England, is probably the best preserved bird of the species.

The Thayer collection recalls the fact that the United States once had parrots living within its borders; four specimens of the excessively rare western race of the Carolina parakeet, a species of parrot, from Oklahoma, will be added to the exhibit of extinct birds already on display at the Museum of Comparative Zoology. There is in Mr. Thayer's collection a series of examples of the extinct Eskimo curlew, or "dough bird," and specimens of the passenger pigeon, the bird which once darkened the western plains, extinct now for thirty years.

The bird skins include many collected by Mr. Thayer's expeditions in the peninsula of lower California. The university collections will also be enriched by a group which fills the gaps in the Harvard series from the Queen Charlotte Islands. There is a series of the Imperial woodpecker from the highlands of northern Mexico, and examples of the now rare ivory-billed woodpecker, together with a section of the cypress log in which is the nesting cavity with the set of eggs found there.

The collection of eggs includes ten eggs of the great auk, extinct since 1845. Harvard has now eleven auk eggs, or about one sixth of those known. There are several California condor eggs, almost the only examples of such eggs found in their natural surroundings. Several eggs of that condor have been secured from birds at the Washington Zoological Park, but few in the wild surroundings of the rocky coast where the bird nests. The first two sets of the eggs of the spoonbilled sandpiper ever found are in Mr. Thayer's collection. A set of "knot's" eggs taken by Admiral Peary on his last trip to the Arctic is included.

MEDALISTS OF THE ROYAL SOCIETY[1]

COPLEY MEDAL, AWARDED TO SIR ARTHUR SCHUSTER

SIR ARTHUR SCHUSTER was the first to show the important information to be got by measuring quantitatively the magnetic deflection of cathode rays. He showed how, by combining this measurement with the potential difference which generates the rays, it was theoretically possible to determine without ambiguity the velocity, and the ratio of charge to mass, of the particles constituting the corpuscular stream. We owe to him other almost equally fundamental contributions to the study of electric discharge in gases. Thus he showed that the passage of a luminous discharge put the gas temporarily into a conducting state, due to the presence of charged ions: these ions were able to diffuse into a space screened from the discharge by a wire gauze partition, and they could then be put into evidence by showing the conductivity of the gas under electromotive forces of a fraction of a volt. Sir Arthur was the first to show by experiment that in Crooke's radiometer the reaction was not on the sun but on the glass case of the instrument, thereby connecting the action with the residual gas. He has also made many important contributions to terrestrial magnetism. In spectroscopy he formulated independently the Rydberg-Schuster law. He invented the periodogram method of looking for periodicities in statistical material, a method which has been widely adopted by workers in many branches of inquiry, extending even into economics.

ROYAL MEDAL, AWARDED TO SIR RICHARD GLAZEBROOK

For fifty years Sir Richard Glazebrook has been closely identified with research on physical standards, and particularly electrical standards. For many years he conducted researches associated with the absolute measurement of resistance, current and inductance, and the results of this work are reflected in the present remarkable accuracy of electrical measurements. The name of Sir Richard Glazebrook is also world-known on account of his directorship of the National Physical Laboratory; it is largely due to his influence on the researches at that institution that aeronautical science has made such vast progress. Physical science is also indebted to him for that great work, the "Dictionary of Physics," and in international science he has played a conspicuous part.

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[1] Extracts, as printed in *Nature*, from the remarks made by Sir F. Gowland Hopkins, president of the Royal Society, in bestowing the medals of the society at the anniversary meeting on November 30.

Royal Medal, Awarded to Professor W. H. Lang

Professor Lang's work on the fossils of the Old Red Sandstone is of high scientific importance. It has led to the discovery and description of a new and unexpected group of plants in which root, stem and leaf are not differentiated. For the first time it thus becomes possible to trace in a circumscribed group the probable origin of these structures from a source in which they did not exist as distinct members. The work was begun in collaboration with the late Dr. Kidston and continued by Professor Lang after the death of his colleague in 1924. Professor Lang's previous intensive studies on the morphology of the liverworts and ferns had eminently fitted him to provide a morphological point of view which has given most important results.

Davy Medal, Awarded to Professor A. Lapworth

Professor Lapworth's work has been largely concerned with the application of physical methods to the investigation of the reactions of organic chemistry. His study of the bromination of acetone yielded results of primary importance in relation to the reactivity of carbonyl compounds and has formed the basis of many subsequent investigations. His researches on the addition of hydrocyanic acid to organic compounds, besides leading to results of theoretical and synthetical importance, made clear the mechanism of the formation of cyanhydrins. His investigations of the effect of small quantities of water in diminishing the activity of acids in alcoholic solution indicated the existence of the oxonium ion and added considerably to our knowledge of catalysis by acids. Among his more notable synthetical achievements are the synthesis of zingerone, derived from the pungent principle of ginger, and of homocamphor. His work on the mutual influence of groups in the same molecule, his recognition of induced alternate polarity and his classification of reagents as anionoid or kationoid have played an important part in the development of the present state of knowledge of the reactivity of organic compounds.

Sylvester Medal, Awarded to Professor E. T. Whittaker

Professor E. T. Whittaker is one of the best known of British mathematicians, his work showing extraordinary versatility. He has written five books, on entirely different subjects, and numerous papers which touch on almost every branch of mathematics. All his books show, besides their more technical qualities, powers of arrangement and exposition of a most unusual order; and the "Modern Analysis" and "Analytical Dynamics" have had a considerable influence on mathematical thought. Professor Whittaker has made important additions to the theory of the solution of differential equations, ordinary and partial, by definite integrals; to the theory of Lamé and Mathieu functions, the functions of the elliptic and parabolic cylinders and the integral equations associated with them; to the theory of interpolation; and to the theory of the solution of dynamical problems by trigonometrical series. He has also in recent years made a number of interesting contributions to the pure mathematics of relativity, electromagnetism and quantum theory.

Hughes Medal, Awarded to Professor W. L. Bragg

Professor Bragg's recognition of the fact that the Laue diffraction spectra could be considered as produced by reflection from the planes of the crystal lattice, besides being a great simplification of a difficult geometrical problem, was the starting point of two important and fruitful lines of physical investigation, namely, the measurement of x-ray wave-lengths and the elucidation of crystal structure. Work on the first of these led to Moseley's discoveries and their subsequent developments. Bragg's concentration on the second has resulted in a wonderful extension of our knowledge of the structure of crystals, both simple and complex, and of inter-atomic distances and linkages. His work may truly be said to have laid the foundations of a chemistry of the solid state.

AWARD OF THE CHANDLER MEDAL TO PROFESSOR CONANT

The Chandler Medal for achievement in chemical science has been awarded for 1931 to Professor James Bryant Conant, chairman of the division of chemistry in Harvard University, according to an announcement recently made by Professor Ralph H. McKee, at Columbia University, chairman of the Committee on the Chandler Lectureship.

Professor Conant will receive the medal at a national gathering of scientific men in Havemeyer Hall, Columbia University, at 8:15 P. M., on February 5. He will deliver the annual Chandler lecture.

The medal, an outstanding distinction in chemistry, was instituted in 1910 by friends of the late Professor Charles Frederick Chandler, pioneer in industrial chemistry, and a founder of the American Chemical Society. The award was established with a gift which constitutes the Chandler Foundation.

Previous medalists include Dr. Irving Langmuir, Leo H. Baekeland, W. A. Hillebrand, W. R. Whitney, F. Gowland Hopkins, Edgar F. Smith, Robert E. Swain, E. C. Kendall, S. W. Parr, Moses Gomberg and J. Arthur Wilson.

The announcement describes Professor Conant as "one of the most brilliant of the younger organic chemists which this country has produced." He was born in Dorchester, Massachusetts, in 1893. From Harvard he received the A.B. in 1913 and the Ph.D. in 1916.

Upon his graduation he became an instructor in chemistry at Harvard University, and in the following year entered the army as a lieutenant in the Sanitary Corps, later becoming a major in the Research Division in the Chemical Warfare Service.

At the close of the war Professor Conant returned to Harvard as an assistant professor of chemistry. He became an associate professor in 1925, and a full professor in 1927. Meanwhile he had acted as a visiting lecturer at the University of California Summer School.

Professor Conant is a former chairman of the Organic Division of the American Chemical Society. He is the author of "Organic Chemistry," and joint author of "Practical Chemistry." He has written a series of papers on subjects relating to physical organic chemistry, in which field he has been extensively engaged.

His research has included work in reduction and oxidation, hemoglobin, free radicals and a quantitative study of organic reactions. He is a member of the American Academy of Arts and Sciences and of the National Academy of Sciences.

SCIENTIFIC NOTES AND NEWS

The American Association for the Advancement of Science, with some thirty-five affiliated and associated scientific societies, has been meeting this week in New Orleans. This is the second New Orleans meeting, the first having been held there twenty-five years ago. Full information concerning the meeting was given in the preliminary announcement printed in the issue of SCIENCE for November 27, and supplementary statements have been given in other issues. A report of the meeting edited by the permanent secretary will appear in the issue of SCIENCE for February 5.

Dr. William King Gregory, of the American Museum of Natural History, was elected president of the New York Academy of Sciences for 1932 at the annual meeting held in New York City on December 21. The address of the retiring president, Dr. Clark Wissler, was delivered after the annual dinner. Dr. Wissler's subject was "The Primitive Background of Civilization."

Mr. H. P. Charlesworth, vice-president of the Bell Telephone Laboratories, New York, has been officially nominated for the presidency of the American Institute of Electrical Engineers.

It is announced that Dr. Harvey Cushing, surgeon-in-chief of the Peter Bent Brigham Hospital and Moseley professor of surgery at the Harvard Medical School, will retire on September 1. He will reach the age of retirement of sixty-three years on April 8.

The governors of the University of Toronto have accepted with regret the resignation of Professor J. C. McLennan, dean of the school of graduate studies, professor of physics and director of the physical laboratory. Professor McLennan has been granted leave of absence from the end of January and he and Mrs. McLennan will leave at that time to live in England. His resignation takes effect at the end of June, 1932.

Professor E. Freundlich, director of the Astrophysical Observatory at Potsdam, delivered on December 2 a lecture on the results of the Potsdam Solar Eclipse Expedition to Sumatra in May, 1929, to determine the deflection of light in the sun's gravitational field and to examine its variation with distance from the sun.

Dr. Edward Tyson Reichert, professor of physiology at the University of Pennsylvania from 1886 until his retirement in 1920, died in Florida on December 25, aged seventy-six years.

Dr. Daniel Draper, who until his retirement in 1911 had been official meteorologist in New York City for forty-two years, died on December 21 at the age of ninety-one years.

The Cullum Geographical Medal of the American Geographical Society for 1931 has been awarded to Professor Mark Jefferson, of the Michigan State Normal College. The presentation will be made at the twenty-eighth annual meeting of the Association of American Geographers.

Sir Charles Sherrington has been awarded the first Hughlings Jackson Medal of the Royal Society of Medicine and will give the first triennial lecture before the neurological section of the society. The medal and lecture have been established with a fund of £1,110 subscribed in memory of Hughlings Jackson, the distinguished British neurologist.

The Royal Meteorological Society has awarded the Symons Gold Medal to Professor V. F. K. Bjerknes, of the Physical Institute of the University of Oslo.

The medal will be presented at the annual meeting on January 20.

DR. CARROLL W. DODGE, of Harvard University, has been appointed to a professorship in the Henry Shaw School of Botany of Washington University, St. Louis.

DR. JOHN E. BUCHER, formerly head of the department of chemistry at Brown University, consulting chemist of New York City, has become a member of the staff of Antioch College Research Institute, at Yellow Springs, Ohio.

DR. C. B. WILLIAMS, lecturer in agricultural and forest entomology at the University of Edinburgh, has been appointed head of the department of entomology at Rothamsted Experimental Station.

DR. H. C. DARBY has been appointed lecturer in geography at the University of Cambridge.

THE title of emeritus professor has been conferred by the University of Birmingham upon Frederick William Burstall, from 1896 to 1931 professor of mechanical engineering, and on Arthur Robert Ling, from 1920 to 1931 Adrian Brown professor of brewing and head of the department of malting and brewing and the biochemistry of fermentation.

DR. KITASHIMA, formerly vice-director of the Kitasato Institute, Tokyo, has been unanimously elected director to succeed the late Baron D. Kitasato, founder and director of the institute. Dr. S. Hata has been elected vice-director.

THE sum of $2,500 which the Rosenwald Fund has placed at the disposal of the American National Committee of the International Union for the Scientific Investigation of Population Problems has been applied to two fellowships. A fellowship of $1,800 for one year has been awarded to Dr. E. E. Lewis, of Howard University, who is carrying on an investigation on "The Economic Aspects of the Shifts in Negro Population," and one of $800 for one year to Miss Betty Freeman, of the Johns Hopkins University, who is investigating "The Relation between Fertility in Women and Longevity." A grant of $500 has also been made to Miss Mary Dublin out of the general fund of the committee, to meet expenses in the conduct of her investigation at the London School of Economics into "The Influence of the Declining Birth Rate on the Mortality from Puerperal Causes."

IT was announced at the anniversary meeting of the Royal Society, as reported in *Nature*, that this year the following grants have been made: From the Messel Fund: £800 a year for five years to Dr. Honor B. Fell, of the Strangeways Research Laboratory, for the support of her valuable work on tissue culture; also £150 for the current year, and, after the termination of his 1851 Exhibition Scholarship, £600 a year for two years, to Dr. M. L. Oliphant, of the Cavendish Laboratory. From the Caird Fund: £2,200 to Professor O. W. Richardson for the purchase of optical apparatus of high resolving power. From the Donation Fund: £400 to Dr. L. S. B. Leakey towards the cost of his West African Archeological Expedition. From the Darwin Fund: £500 a year for four years to Mr. C. S. Elton for research on wild vole populations, together with an additional grant of £250 for capital outlay and field equipment. Dr. S. Adler's researches on kala-azar continue to receive support from the Anonymous Bequest Fund.

A CORRESPONDENT writes: "Professor P. Langevin, of the Collège de France, Paris, who has been in China for some time on an International Educational Mission on behalf of the League of Nations, has accepted the joint invitation of the National Academy of Peiping, the National University and the National Tsing-Hwa University, China, to give a series of colloquium lectures to the physicists and advanced students in physics there. The lectures are expected to continue for one month. The subject chosen by Professor Langevin is: "Les nouvelles dynamiques de relativité et des quanta et leur applications à quelques problèmes de la théorie du magnétisme." It is hoped that the presence of Professor Langevin and his lectures will serve as a stimulus to the building up of an atmosphere and a nucleus for research in physical science in that region—an atmosphere that has been gradually taking shape. In Peiping there are six universities with physics as a department, besides one institution purely for research on that subject. Steps are also under way towards the formation of a physical society with aims and organization along the line of those existing in other countries."

SENATOR HAWES of Missouri and Senator Walcott of Connecticut have introduced a bill which would coordinate the various federal agencies dealing with the conservation of wild life, both plant and animal, including forests, fish and game.

THE British Museum has acquired for its department of manuscripts nine volumes of nineteenth and twentieth-century autographed letters, presented by Dr. C. Davies Sherborn. Almost half the letters are from eminent scientific men, though art and literature, music and drama, and politics and the professions fill five volumes. The names include those of Huxley, Darwin, Geikie, Lyell and Livingstone.

THE Department of Medicine of the New York Post-Graduate Medical School and Hospital of Columbia University announces the opening of a clinic devoted to the study of the capillaries in a variety of diseased conditions. Representatives of the following specialties will study the capillary changes in the diseases in which they are interested: Diseases of metabolism; diseases of the cardio-respiratory system; diseases of the endocrine glands; migraine, arthritis, tuberculosis and allergic conditions; diseases of the nervous system, and surgical conditions of the extremities. Cases or groups of cases of sufficient interest will be studied in greater detail in the capillary laboratory already established at this institution.

THE annual general meeting of the Association for the Promotion of Cooperation between Scientific and Technical Societies and Institutions within the British Empire was held, according to *Nature,* at Burlington House, London, on December 1. The report, which was adopted, referred to the appeal for a central building in London issued in February of this year to the members of the constituent societies and institutions, in which it was stated that options had been secured for a limited period on a site near Westminster Abbey, and that an estimated sum of £350,000 would be required to defray the cost of the complete building, including the purchase of leases, etc. It was further mentioned that to complete the purchase of the leases it would be necessary to secure £100,000 in cash by June 24, 1931, when the options on the site would expire. A considerable response to the appeal was received, but the sum available by June 24, however, fell considerably short of the amount required in cash, and the Council of Management decided to allow the options on the leases to lapse. The acute financial and industrial conditions prevailing during this year, culminating in the recent crisis, have rendered it necessary for the council to postpone a public appeal until national conditions have improved. Though regretting the consequent delay in proceeding with the central building scheme, the council will not relax its efforts to bring the scheme to fruition at the earliest possible moment.

IN their report to the University of Cambridge on forestry in the university curriculum the General Board states that it has been much concerned about the future of the Department of Forestry. There is practically no future for graduates trained in forestry except in Government Forest Services. Only twenty to twenty-five of these posts are available each year, and there are no fewer than five university schools, including the one at Cambridge, engaged in training candidates for these posts. As a result of investigations the committee of the General Board came to the conclusion that the university would not be justified in maintaining a forestry organization as a recruiting ground for government services, partly because the demand was so small, but even more because they considered that university policy in forestry teaching can not be reconciled with the present official view. They accordingly recommend that the Department of Forestry be suppressed, examinations in forestry for the ordinary B.A. degree be discontinued after 1934, and examinations for the diploma in forestry cease in October, 1935. The titles of faculties and examinations concerned would be amended where necessary by the deletion of the word "forestry."

THE Acadia National Park, in Maine, which includes a considerable part of the famous Mount Desert Island and about half of Schoodic Peninsula, to the east across Frenchman Bay, is shown on a new map just issued by the United States Geological Survey, Department of the Interior, on a scale of 1 mile to the inch, with the surface forms indicated by contour lines drawn at vertical intervals of 20 feet. Mount Desert is far from a desert: the name given by Champlain, "l'isle des monts deserts," was applied with the original French signification of the word "deserts"—that is, wild and solitary, not devoid of vegetation. The island vegetation is exceptionally vigorous and combines with the rugged beauty of this part of the Maine coast to make a landscape of superb attractions. The national park, the only one on the seashore, includes much of the wildest part of the island. The map shows clearly the remarkable variety of land forms and coastal waters, and on the back of the map is a simply written account of the geology of Mount Desert, from the time when the granitic rock that now forms most of its surface was a plastic molten mass to the events that have modified the surface since the glacial invasion.

A GOLD medal for anthropological research is in future to be awarded annually by the Royal Anthropological Institute for the best research essay written on the application of anthropological methods to the problems of native peoples, particularly those arising from intercourse between native peoples, or between primitive natives and civilized races. The medal, which is to be known as the Wellcome Gold Medal for Anthropological Research, has been provided by Dr. Henry S. Wellcome, and will be bestowed at the annual meetings of the Royal Anthropological Institute, at the recommendation of a special medal committee. The president of the Royal Anthropological Institute will be the chairman of this committee, while of the other members one will be the conservator of the Wellcome Historical Medical Museum, the three remaining persons being nominated, respectively, for a period of three years, by the presidents of the Royal Anthropological Institute, the Royal Empire Society and the African Society. Candidates for the medal may be of any nationality, but the essays must be submitted in English. If unpublished, they are to be submitted, at the discretion of the medal committee, for publication by the Royal Anthropological Institute.

The essays are intended to be of moderate length, and must be delivered in triplicate copies at the office of the Royal Anthropological Institute by the first of January in the year when they are to be considered by the committee. The first award of the medal will be made next year.

THE *Journal* of the American Medical Association reports that the Prince Leopold Institute of Tropical Medicine, recently established at Antwerp, has for its purpose the creation and maintenance of a school of hygiene and of tropical medicine, for the training of colonial physicians and sanitary agents; for the study of all problems pertaining to the etiology and the therapeutics of tropical diseases, and to establish laboratories and clinics as annexes of the school. The courses given in the new institution will be organized in such a manner as to meet the requirements of the curriculum established by the minister of the colonies for physicians in the government service.

THE London *Times* reports that a new development in the scientific investigation of those problems of marine biology the solution of which is of importance to the fishery industry was marked by the formal opening at the University College of Hull of new fishery research laboratories for the department of zoology and oceanography. When the Hull University College was founded a few years ago one main object of the promoters was the establishment of a department of marine biology by which it was hoped to render scientific services to the fishing industries, and the college authorities appointed as head of this department Professor D. C. Hardy, who, after spending some years in the laboratories of the Ministry of Agriculture and Fisheries at Lowestoft, had joined the scientific staff of the *Discovery* and had then recently finished his work with that expedition. At Hull Professor Hardy has extended his earlier work in fishery research, and that it is appreciated by the fishing industry was shown by the presence of Sir John Marsden, president of the British Trawlers' Federation, who opened the new laboratories, and of Mr. H. G. Maurice, Fisheries Secretary of the Ministry of Agriculture and Fisheries. Professor Hardy is now hoping that both the herring and the trawling sides of the British fishery industry will join in forming a small committee to keep in touch with the fishery research work of the college. The basic problems affecting the fishing industry center in plankton, its different varieties, the different kinds of organisms it contains, the study of the different localities in the ocean where these different kinds most exist, the motions to which areas of particular species are subjected by the ocean currents, the kinds of fish that are attracted to or repelled by the different waters, and the ascertainment of the facts which determine the movements of these varying feeding grounds of the different species of fish. The whole study is now pursued on international lines by the scientific men of many countries, who are united in the International Council for the Exploration of the Sea. It is hoped that the work at Hull will fit into and form part of this plan of oceanographic research.

THE regular correspondent of the *Journal* of the American Medical Association reports that a record low death rate and a low infant mortality rate are the two main features of the annual demography bulletin for 1930, which deals with the population and vital statistics of Australia. The infant mortality rate was 47 per thousand; with the exception of the New Zealond rate, this is the lowest in the world. The rate for New Zealand in 34.5. The death rate was 8.59 per thousand of the population. This rate was the lowest ever recorded in Australia and compares most favorably with that of other countries. The principal causes of death were heart disease, 15.6 per cent.; cancer, 11.1 per cent.; tuberculosis, 5.9 per cent.; acute and chronic nephritis, 5.7 per cent., and pneumonia, 3.5 per cent. The maternal mortality rate was 5.29 per thousand children born. At the end of 1930 the population of Australia reached the total of 6,476,032, which represents a growth of 1,064,735 during the last ten years. To this total gain, natural increase contributed 73 per cent. and net migration 27 per cent. The rate of growth during 1930 was 1.81 per cent., and is among the highest rates of increase in the world. The birth rate was 19.93 per thousand of population, the lowest ever recorded. Compared with that of many other countries, the Australian rate is low, but fortunately it is accompanied by a low death rate giving a rate of natural increase which is equaled in few countries. Exnuptial births were 4.62 per cent. of all births registered. The average family per mother in 1930 was 2.92 as against 2.96 in 1929. The density of population, that is, the number of persons to the square mile, in Australia is only 2.18 and varies from 1 person in 100 square miles in the Northern Territory to 20.38 to the square mile in Victoria.

DISCUSSION

TWISTING IN LOWER FORMS OF PLANTS

WITHIN recent months a number of notes have been published in SCIENCE regarding twisting in the bark and wood of trees. Various factors have been invoked to account for the twisting, such as sunlight and wind, thus explaining the more frequent occurrence of twisted trees on the edge of forested areas rather than within them.

The supposed influence of position as related to the sun and to prevailing winds has suggested that if the right twist is more common in the northern hemisphere, as the results would indicate, the left twist should be more common in the southern.

Twisting in vines and their tendrils is familiar to all; the direction of the twist is, I believe, quite constant for any species. Different trophisms have been thought to be the cause, and a frequent experiment is to determine the effect of rotation of the plant in different axes on the twisting.

It may not be known to many that a similar phenomenon has been noted in lower forms of plant life. Boas[1] described and pictured a symmetrical bending of the filaments of a colony of *Oidium lactis* growing on agar. He stated that he has also noted the same symmetrical bending of the hyphae in the case of the molds, *Penicillium brevicaule* and *Rhizopus nigricans.* He believes the spiral-like growth is widespread among the fungi.

The bending of the threads, consisting of a number of parallel rows of cells, of the bacterium variously known as *Bacillus mycoides* or *Bacillus ramosus,* is a striking example of what seems to be comparable to the twisting in higher plants. This organism, when seeded at one point on the surface of a disc of agar, spreads out uniformly in all directions. The appearance to the eye is that of a tangled mass of threads, the main branches of which bend in a uniform direction. The bending of the threads in the various strains which the writer has isolated is counter clockwise. Strains have been described by European bacteriologists in which the bending is to the right and others are what might be called neutral, the bending being neither to the left nor to the righ in an apparent manner. These various forms are thought to be identical in other respects, as determined by the usual methods of the bacteriological laboratory, including the antibody reactions.

The factors, wind, sunlight, etc., which have been invoked to explain the twisting of higher plants, do not enter here. Several have studied the effect of position on the bending and have noted no effects. The writer, following the lead of the botanists, has observed the effect of rotation of the culture during its growth. The constant rotation of the culture on a horizontal axis parallel to the surface of the substratum exerts no influence on the appearance of the growth, nor does rotation on a vertical axis at a right angle to the surface of the substratum, while rotation on an horizontal axis at a right angle to the surface of the substratum causes such a lack of symmetry as to be recognizable by observers ignorant of the conditions existing during growth. The distortion is noticeable not only in lack of symmetry but in the breadth of the threads. The distortion is most marked when the rotation is in the same direction as the normal bending of the threads, that is, counter clockwise.

If the bending of the threads of the bacterium is comparable to the twisting of vines and trees, the lower organism offers many opportunities to the student to measure the effect of this and that factor and possibly to discover a more adequate explanation than those yet presented. The writer, for example, is attempting to find what may be the effect of growing the organism in the southern hemisphere through the aid of a friend in Australia.

It is possible to obtain a growth in which the bending is not present, by using a medium which is less firm than the usual agar of the laboratory. Changing the type of growth does not, of course, offer any explanation for the usual bending of the threads in a definite direction. One writer has spoken of biological isomerisms, the three forms of the organism being comparable to the left, right, and inactive compounds as regards polarized light. Variation in the spacial arrangement within the cell may be a common occurrence. It may account for the type of optical activity of the compounds formed by organisms.

E. G. HASTINGS

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METEORITES IN SEDIMENTARY ROCKS?

FOR many years I have searched for meteorites or meteoritic material in sedimentary rocks. About fifteen years ago, one of my students found a meteorite in a bed of gypsum in western Oklahoma. At first, it was thought that the occurrence represented a fall at the time of the deposition of the gypsum, which is Permian in age. A careful study of the occurrence of the meteorite, however, proved that it was evidently recent. I have interviewed the late Dr. G. P. Merrill, of the U. S. National Museum, and Dr. G. T. Prior, of the British National History Museum, both well-known students of meteorites, and neither man knew of a single occurrence of a meteorite in sedimentary rocks. Dr. Prior knew of a meteorite that was found in recent stream gravels but of none occurring in sediments of past geologic periods.

This letter is a petition for any information indicating that meteorites do occur in the sediments. Dr. Merrill was of the opinion that we should not expect to find them in the sediments because they would decompose before they could be buried. Although we may admit that the iron-nickel meteorites might undergo rapid oxidation under the conditions of weathering on the land surface and the stony meteorites at a slower pace, if a meteorite of any type fell in a sea in which muds or limestones were accumulating, why should it not be buried in these sediments? We know that many of the minerals of the stony meteorites are similar to those of the terrestrial rocks and that the minerals of the latter may be buried without undergoing decomposition. We find arkosic rocks and graywackes (which contain minerals that under normal weathering conditions decompose entirely) that have been buried and constitute integral parts of sedimentary rocks.

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[1] *Zentb. f. Bakt.,* II, 49, 412. 1918.

An iron meteorite falling in sea water would be rapidly attacked (unless quickly buried) and the exterior converted into iron oxides which would protect the inner portion, in some degree at least, from complete alteration. Even if such a meteorite were completely altered to iron oxides, these should remain as a type of pseudomorph of the original meteorite. Unless the nickel which normally occurs in iron meteorites were all removed during the oxidation, its presence in the resulting ferruginous mass might be taken as evidence of the meteoritic origin of the mass. I have never found any material which suggested that it was of this origin or which seemed to merit being tested for nickel. It is equally difficult to believe that a stony meteorite, falling in a soft mud or calcareous ooze would not be buried before decomposition took place.

The presence of meteoric material in deep-sea muds has little real bearing on the question, as this material may be recent. It is in the possible occurrence of meteorites in the ancient sediments that I am interested. I will appreciate any information any one may have regarding this interesting quest.

W. A. TARR

UNIVERSITY OF MISSOURI

POSSIBLE RELATION OF AGE AT SEXUAL MATURITY IN BIRDS TO DAILY PERIOD, INTENSITY AND WAVE-LENGTH OF LIGHT

IN a recent paper, Riddle[1] shows that, in pigeons and doves, age at first sexual maturity is hastened if the bird reaches an age of 4 to 5 months between February 1 and July 31, and is delayed if this age is reached in autumn. The delay may reach 36 per cent. in pigeons and 52 per cent. in doves. This is brought about by endocrine conditions (thyroid and perhaps pituitary) connected with this part of the year. Earlier studies had shown that the season of accelerated sexual maturity is also the season when, even in mature birds, thyroid size and activity is decreasing. He found a seasonal factor in practically all aspects of sex and reproduction studied in doves and pigeons.

Rowan[2] shows that the seasonal changes of the gonads and occurrence of sexual maturity in the junco, with a single seasonal sexual cycle, is conditioned by length of daily period of illumination. He thinks the change of light period does not act *per se* but by prolonging or shortening the daily periods of muscular exercise. He has since come to the conclusion that this relation holds also for the crow in Alberta, Canada.[3] He altered the sexual cycle in the junco and crow by artificially lengthening or shortening the daily period of illumination for the birds. This is related to the changes of the sex glands and through them or with them to migration in these birds.

The writer[4, 5] has reported the close relation of attainment of sexual maturity in the European starling in Hartford, Connecticut, (with single seasonal cycle) to the daily period of illumination, whether of natural or artificial light. This is not caused by changes of periods of muscular exercise in the starling as claimed for the junco by Rowan. However, increased periods of muscular work were found to prolong the refractory period before light-induced testis changes appear and perhaps to increase the rate of acceleration of changes once begun as the result of light change.

In a later study,[6] it is shown that light intensity is a factor in the induction of sexual maturity in the starling, when the periods of daily light are equal. Up to a certain light intensity, rate of acceleration of germ-cell activity, induced by added light treatments of equal duration, varies with the light intensity. Increase of daily period of illumination, even with low intensity of added electric light will induce sexual maturity in both first-year birds and those over a year old and sexually mature at least once before. This may be brought about even in midwinter at midwinter temperature. Sexual maturity occurs in nature only in April, May and very early June.

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[1] O. Riddle, "Studies on the Physiology of Reproduction in Birds. XXIX. Season of Origin as a Determiner of Age at which Birds Become Sexually Mature." *Am. Jour. Physiol.*, 97 (4): 581–587, 1931.

[2] Wm. Rowan, "Experiments on Bird Migration. I. Manipulation of the Reproductive Cycle: Seasonal Histological Changes in the Gonads," *Proc. Boston Soc. Nat. Hist.*, 39: 151–208, 1931. See list there.

[3] Article in *New York Times*, July 21, 1931, "To Use 1,000 Crows in Evolution Tests, etc."

[4] T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. I. Sexual Maturity, Its Modification and Possible Control in the European Starling (*Sturnus vulgaris*): a General Statement," *Am. Jour. Anat.*, 45: 289–305, 1930.

[5] T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. IV. Experimental Modification of the Sexual Cycle in Males of the European Starling (*Sturnus vulgaris*) by Changes in the Daily Period of Illumination and of Muscular Work," *J. E. Z.*, 58: 281–319, 1931a.

[6] T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. V. Effects of Light of Different Intensities upon the Testis Activity of the European Starling (*Sturnus vulgaris*)," *Phys. Zool.* in press, 1931b.

In a further study,[7] it was found that the degree of effectiveness of the light and the character of its effect depend on the wave-length of the light used, when the luminous intensity is the same in artificial additions to daily sunlight period inside a room behind window glass. Red light, at relatively low intensity of illumination, induces sexual maturity in as short time as 23 days in midwinter, while green at the same intensity does not induce it at all, but inhibits it, in males at least. This occurs in juvenile birds of the previous summer's broods as well as in older birds.

It is known that spring sunshine is relatively rich in long red wave-lengths and poorer in the shorter wave-lengths of light, while summer and autumn sunlight is richer in shorter wave-lengths in comparison. So the *same intensity of sunlight in spring is more* stimulating to sexual maturity than in autumn or summer, for it contains relatively more of the stimulating red rays.

In view of all the above findings, it is suggested that Riddle's results point to a conditioning of the age at first sexual maturity in doves and pigeons, which have polyoestrous cycles, as well as in juncos, crows and starlings, with single yearly sexual activity, by the action of increasing or decreasing effectiveness of daily light periods. This effectiveness depends on length of period, intensity and wave-length of illumination per day. This may be affected by the above mentioned changes of the relative amounts of longer, stimulating rays and shorter, inhibitory wave-lengths of light incident to the season and height of the sun above the southern horizon. This is probably correlated with the endocrine functions of the thyroid and anterior pituitary glands as Riddle suggests.

The following scheme is suggested to describe the relation of age at first sexual maturity to the endocrine function and to the acceleration or delay of sexual development in birds on the basis of Riddle's, Rowan's and Bissonnette's experiments:

E = basal endocrine stimulus to sexual development of each race, or bird.
$-L$ = action of shortening days with decreasing intensity and less long-wave light.
$+L$ = action of lengthening days with increasing intensity and relatively more long-wave light.
R = Rate of development to sexual maturity in birds nearing the 4–5 month age at any time.
A = Age at first sexual maturity.
For July to January, $R = E - L$.
For February to June, $R = E + L$.

$$A = \frac{K}{R} = \frac{K}{E \pm L}$$

where K is a constant for the breed of bird. Birds mature early if they reach 4 to 5 months of age when $+L$ is effective, in February to June, and late if $-L$ is effective, in July to January.

It would be interesting to test the correctness of this suggestion by treating young doves or pigeons, of known breeding behavior, with various types of daily light period as has been done with the starlings. If it is valid, the age at maturity in these birds can be modified at will, irrespective of season.

T. H. Bissonnette

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"ENTAMOEBA" PHALLUSIAE

Mackinnon and Rae describe *"Entamoeba" phallusiae* in the June number of the *Journal of the Marine Biological Association* of the United Kingdom. This note is written merely to call attention to the slight doubt whether the form described is an *Entamoeba*. *Entamoeba* has a centronucleus (Boveri's very convenient term) containing a centrosome with a centriole, as have also many small amoebae, *e. g.*, most soil amoebae. From the figures and description of *"Entamoeba" phallusiae* one is in doubt as to the presence of an intranuclear centrosome, Fig. 3, A, B, and C suggesting, but not showing it.

The parasitic habit is not enough to determine that a species is an *Entamoeba* rather than an *Amoeba*, though it makes it probable that it is so. The chief distinction between the two genera is in the presence or absence of a centronucleus. Species of the true genus *Amoeba* have not been found to contain a centrosome, with centriole, in the nucleus. Many minute soil amoebae are morphologically *Entamoebae* and should be so recognized in spite of the absence of the parasitic habit. Habitat is hardly a proper determinative feature for generic diagnosis.

Amoeba, of course, is clearly a valid genus (See Mast and Johnson, Archiv f. Protistenkunde, 75, 1, 1931). Many so-called genera both of *Amoebae* and of forms with centronuclei when treated as subgenera give as good or a better idea of probable relationship.

Maynard M. Metcalf

The Johns Hopkins University,
October 29, 1931

NATURALLY DEPOSITED EGGS OF THE MYXINOIDEA (HYPEROTRETIA)

Ever since J. Müller (1843) described the genital system of the myxinoids, many interested zoologists in Europe and America have attempted in vain to find the naturally deposited eggs of these eels. In

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[7] T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. VI. Effects of White, Green and Red Lights of Equal Luminous Intensity on the Testis Activity of the European Starling (*Sturnus vulgaris*)," *Physiol. Zool.*, in press, 1932.

1896 a Chinese fisherman, who had accidentally brought to the surface on trawl lines some eggs of *Bdellostoma stouti* near Monterey, California, collected a number of the eggs for G. C. Price, Bashford Dean and others. The fisherman would reveal to no one how or where he secured the eggs, and his secret died with him.

Through the courtesy of the Boston Society of Natural History, the Committee on the Permanent Science Fund of the American Academy of Arts and Sciences, the Bashford Dean Memorial Committee of the American Museum of Natural History and the National Research Council, I have been able to search during several summers for the naturally deposited eggs of Myxine and Bdellostoma. In the summer of 1930 I succeeded in collecting between five and six hundred naturally deposited eggs of *Bdellostoma stouti* near Monterey, California; at least 130 of the eggs had embryos.

No one has succeeded in finding naturally deposited eggs of Myxine, and the many attempts to obtain fertilized eggs by keeping the eels in captivity have failed. While fishing during the months of July, August and September, 1931, near the mouth of Frenchman Bay, five miles from Bar Harbor, Maine, I succeeded in collecting about fifty naturally deposited eggs of *Myxine glutinosa*. The eggs were brought up from the bottom of the ocean in from thirty to thirty-five fathoms of water.

My experience in searching for the eggs of both Bdellostoma and Myxine leads me to the conclusion that the eels do not migrate, and that they deposit their eggs at all seasons of the year in certain favorable spots very near their feeding grounds.

J. LeRoy Conel

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SEDIMENTATION AND SEDIMENTOLOGY

"Sedimentation," as generally understood, is that branch of geology which deals with the processes of sedimentation and the origin of the sedimentary rocks.

Webster's New International Dictionary for year 1929 says: "Sedimentation is an act or process of depositing sediments."

The current use of the term in geology is ambiguous and in some cases incorrect. Geologists in general have not taken very kindly to the term "sedimentationists," but resort to cumbersome phrases such as "petrologists interested in sedimentary rocks" or "petrologists working on sedimentary deposits." It is questionable if the use of the phrases "sedimentary petrology," and "sedimentary petrologist" side by side with "sedimentary deposists," *i. e.*, deposits formed by sedimentation, is correct.

Sedimentology is here suggested as a term for the subject taught, retaining *sedimentation* for the act or process of deposition. The new term and its derivatives *sedimentologist, sedimentologic and sedimentological,* will tend toward clearness. *Sedimentology* and *sedimentation* have their analogies in *glaciology* and glaciation, respectively.

Hakon Wadell

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REPORTS

SCIENCE BOOKLETS FROM THE AMERICAN ASSOCIATION

In 1929, a suggestion to the council of the American Association for the Advancement of Science brought about the appointment of a special committee on the preparation of a series of science booklets for distribution to the American public.

This committee was to arrange for selecting the most appropriate books on each of twenty-seven subjects deemed most important in the field of pure science, and to secure the cooperation and collaboration of numerous scientists, librarians and others familiar with these books. The committee was also to find funds with which to pay for the printing of the lists when ready.

In this series the applications of science to industry and invention are not developed to any great extent; it is hoped that lists on the industrial sciences, especially on the applications of the physical sciences, may be worked up into similar lists by some other national body.

In the fall of 1929, tentative title lists, containing a considerable surplus of titles beyond the twenty-five which had been set as the maximum number for any one list, were mailed to a large number of prominent scientists and to some of the larger public libraries and museums, asking for votes on the most suitable books and cancellation of the least desirable titles, as well as for editorial suggestions that would make the lists most useful for the purpose.

This purpose was very carefully defined; it appears on each of the printed lists:

> These lists have a three-fold object: (1) To select and describe a few authentic and especially interesting books acceptable to the "general reader"; (2) to supplement these with several introductory treatises in understandable style; (3) to suggest a group of text-books for more advanced study by ambitious amateurs, or persons studying by themselves. Books written in America, recent and not out of print, nor too expensive, have been favored, but there are numerous exceptions. The books can generally be borrowed from libraries, or bought from bookstores. Libraries which lack these titles may able to borrow them

from the state library commission, or some other large library, by the inter-library loan system.

The routine work in handling the correspondence, in gathering, sorting, challenging and preparing titles was handled largely on the personal time, out-of-hours, of the librarian and one member of the staff of the Enoch Pratt Free Library of Baltimore, with some clerical help from the Library, where the latter work was justified on the basis of the advantages which it gave to the scientific department of the library in reorganizing and understanding its own collections. Valuable help was given by Miss Jeannette Lucas, Assistant in the Library of the American Museum of Natural History, Mr. Leslie T. Little, of the Waltham Public Library, and by Mr. Gilbert Ward, Head of the Science Department of the Cleveland Public Library.

In February, 1931, a semi-final mimeographed list was sent out again to over 400 names. The 300 new returns made it fairly easy to decide on the final lists. Even here, however, the fresh arrival of newly published books made some complications, and the experience of some libraries with the demands of their readers, warranted challenging some of the decisions from the view-point of the public. In many cases, special letters were sent back and forth to the cooperators in discussing points raised. Where a decision was difficult, special memoranda were prepared and sent to a new group for additional votes on which to base final decisions.

What should be done, for example, when one of the officers of a national group marks one nature handbook as "the only one worth consideration," while several colleagues cross it off altogether, and crosses off a study guide which another professor considers good enough to star? The votes usually settled such questions.

If anything, the lists are solid and scientific, rather than "popular." Many books actively advertised and sold are not here, while numerous advanced books are included. In general, only books of scientific accuracy are included, but when two of the best known scientific explorers and writers of the present day are voted down by a few scientists for "trying to be too popular" (with considerable success), while their books are well reviewed by other scientists, it is evident that there is a feeling against books written by men of scientific training and standing who are able to hold the limelight too prominently. Some authorities do not favor books written by those who are not full-fledged scientists, even though able and on the whole accurate.

Nearly 400 individuals had a part in this work, nearly 2,000 books were carefully examined, more than 2,000 reviews consulted, and it is felt that the final lists are worthy of being published for general use by individual readers, and as buying lists for libraries and schools. The Committee extends its hearty thanks to all who have so generously cooperated.

The descriptive notes were prepared with the readers in mind. Chief reliance was placed on the *Book Review Digest*, and the various reviews in scientific and popular magazines to which it is the key. In addition, however, such excellent annotated and selected lists as the A. L. A. Catalog, A. L. A. Booklist, Standard Catalog, Scientific Book of the Month Club Review, were used, and the English magazine *Science Progress*, (of which unfortunately there is no American counterpart). *The Scientific American* the *Science News-Letter* and numerous special American scientific magazines were carefully scanned. In preparing the final notes, no less than a dozen sources of critical comment and description were in many instances at hand. The full entry, as to edition, pagination, publisher and price is given in each list.

In the summer of 1930, the Carnegie Corporation of New York generously made a grant of $4,000 to the American Association for the Advancement of Science to meet the expense of printing approximately 40,000 copies of each of these lists, so that they might be distributed free under careful restrictions. In November, 1931, the manuscript was completed on the "Teaching of Science," a subject which was suggested after the main project had been outlined.

The lists, in six-page folder form, the size of a large business envelope, were distributed during November, 1931 (from the association office at Washington), a certain number being sent free to public libraries according to population. Other consignments will be sent to certain universities and museums. Beyond this first distribution, additional copies will be supplied by the American Association for the Advancement of Science from its Washington headquarters, Smithsonian Institution Building, at the cost of additional printing (one cent apiece in quantities of ten and over, of one kind). Individual copies will be sent to readers, for a 5c stamp to cover the cost of handling, one complete set for 30 cents. The lists cover the following subjects: "Science To-day" (General); "History of Science"; "Exploring for Science"; "Mathematics"; "Astronomy"; "Geology"; "Meteorology"; "Physics"; "Chemistry"; "Microscope"; "Biology"; "Bacteriology"; "Botany"; "Wild Flowers"; "Ferns, Mosses and Fungi"; "Trees and Shrubs"; "Zoology"; "Animals"; "Birds"; "Insects"; "The Sea and the Shore"; "Inland Waters"; "Fishes and Reptiles"; "Paleontology"; "Evolution and Heredity"; "Anthropology and Ethnology"; "Teaching of Science." Allowing for the occurrence of some titles in more than one list, there are 539 different titles in the entire series, including some books published as late as June, 1931.

The Committee on Booklists consists of Dean Edward W. Berry, paleontologist, Johns Hopkins University; Dr. Paul R. Heyl, physicist, U. S. Bureau of Standards; Dr. Burton E. Livingston, professor of plant physiology and forest ecology, Johns Hopkins University, and General Secretary, A. A. A. S., and Joseph L. Wheeler, public librarian, Baltimore, chairman.

This project has made it clear that more carefully and interestingly written American books for the public are needed in many fields of science. On such subjects as general and special biology, ethnology, light, atomic and quantum physics and relativity, geology, microscopy and many other subjects, there is serious need for systematic, illustrated works, not necessarily brief "appetizers" at one extreme, nor at the other, the conventional text-book. As to good, attractive text-books, great progress has been made in the last five years. We do, however, need books that have more of the broad outlook, imaginative power and literary background and style which characterize some of the work of our English brethren, such as the recent volumes on biology by Wells and Huxley and by Thomson and Geddes, Gregory's "Discovery," or Singer's "Short History of Biology," and Seward's "Plant Life Through the Ages," not to mention the well-known works of Jeans and Eddington. We have already such worth-while examples as Fairchild's "Exploring for Plants," Allen's "Book of Bird Life," Slosson's books, Cushing's "Osler," Shapley's "Flights from Chaos." These books combine through knowledge and accuracy with some literary style and a sustained vigor; they make a presentation suitable to interest the great army of prospective readers beyond the A-B-C stage. Two 1931 American books which set a high mark are Johnson's "Taxonomy of the Flowering Plants" and Crowder's "Between the Tides."

One definite lack is that of an adequate, interesting history of American science, emphasizing the biographical side. A letter from J. Porter, of Vancouver, well worth reading, appears in the *Literary Supplement* to the London *Times* of August 6, on the lack of American scientific biography. One paragraph says:

> . . . America has not been so fortunate. A generation of the giant workers in geology has passed almost unmarked. Even such interesting characters as Powell and Clarence King and Grove Karl Gilbert have failed to receive adequate notice from writers of biography. In the field of physics a small library has grown up around Franklin, but Joseph Henry and H. A. Rowland have little chance of stimulating future generations.

JOSEPH L. WHEELER

ENOCH PRATT FREE LIBRARY,
BALTIMORE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CULTURAL AND INOCULATION METHODS WITH TILLETIA SPECIES

IN SCIENCE for October 2, p. 341, E. W. Bodine describes a "Double Plate Method used for Culturing *Tilletia levis*," in which I was much interested and to which I might add some further observations.

A similar inverted-plate method was used by Kluyver and van Niel[1] in making cultures of species of *Sporobolomyces* in 1924–1925. This procedure was possible because the basidiospores of this basidiomycetous yeast are shot away from their sterigmata.

The discovery by Buller and Vanterpool,[2] in 1925, that the so-called secondary conidia of *Tilletia tritici* are violently discharged from their sterigmata revealed a phenomenon which finds application in both cultural and inoculation technique with species of *Tilletia*. Since 1925, I have used the double-plate or inverted-plate method as described by E. W. Bodine, or modifications thereof, in culturing species of *Tilletia* other than *tritici* and *levis*. *Tilletia horrida*, *T. holci*, and *T. asperifolia* were found to discharge their secondary conidia in a manner similar to that described for *T. tritici* and *T. levis*, and therefore could be readily cultured by the inverted-plate method. Some investigators have experienced difficulty in germinating the chlamydospores of *T. horrida* and obtaining cultures free from contamination; but by using the inverted-plate method pure cultures of *T. horrida* can be obtained quite readily.

By this method monosporous cultures of secondary conidia can be secured and crossing or hybridization experiments conducted with a fair amount of facility.

Further, the method has also found application in the multisporous inoculation of germinating wheat seedlings by inverting a vigorously growing culture of *T. tritici* or *T. levis* and allowing secondary conidia to "rain down" on the seedlings during the first two or three days of germination. A temperature of 10° to 14°C., and probably darkness also, favored infection. After inoculation, the seedlings were carefully potted and brought to maturity, when a large percentage were found to have developed bunted heads. Doubtless, other species of *Tilletia* discharge their secondary conidia violently and will therefore yield to the methods described above.

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[1] A. J. Kluyver and C. B. van Niel, "Über Spiegelbilder erzeugende Hefenarten und die neue Hefengattung. Sporobolomyces." *Centralb. f. Bakteriologie*, Abt. 2, Bd. 63, pp. 1–20, 1924–1925.

[2] A. H. R. Buller and T. C. Vanterpool, "Violent Spore-discharge in *Tilletia tritici*." *Nature* 116: 934–935, 1925.

T. C. Vanterpool

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A THERMOPHIL NITRITE FORMER

An investigation of the thermophil bacteria of pine woods soils in North Carolina was undertaken as a part of the requirements of the Ph.D. degree at Ohio State University. A thermophil nitrite former was among the organisms studied. Enrichment cultures in inorganic salt solution were made. From these, single cells were isolated with a Barber pipette. In all experimental work done with this organism cultures grown from single cells were used. A brief description of the organism follows.

The organism was found to be an obligate thermophil with an optimum temperature at 55°-60° C. and a minimum at 40° C. It was not killed after eight hours at 100° C. nor after forty-five minutes under sixteen pounds pressure at a temperature of 120° C. in the autoclave but was killed after sixty minutes. It was found also to be an obligate aerobe.

Morphologically, it was a large, motile, spore-bearing rod found singly and in chains. The spores were terminal and exceeded the vegetative rod in diameter. The flagella were peritrichic in arrangement. When it was stained with Gram's stain, three forms were noted, a large Gram positive rod, both sporulating and vegetative, which varied in size from 3.8 to 8 micra in length and 1 to 2 micra in width; a more slender Gram negative form, also sporulating and vegetative, which varied from 3.5 to 7 micra in length and .5 to 1 micron in width; also a transitional form having a Gram negative core on which were Gram positive fragments in the form of bars and granules. From experimental evidence these were found to be different ages of the same organism. The Gram positive were young, the negative old, and the granular middle aged.

The colonies appeared as minute white dots with dense centers, when grown on mineral salt agar plates.

When incubated at 55° C., as all cultures were, the organism could oxidize ammonium salts to nitrite in amounts ranging from one to five parts of nitrite nitrogen per million. This oxidation was most active in a pH of 9.4, very slight at pH 6.3 and ceased at pH 4.8.

It grew on all ordinary organic media, but as a result its oxidizing power was retarded upon reinoculation into mineral salt media, except in the case of potato.

When dextrose was added to the mineral salt medium, concentrations of 2 per cent. and 1 per cent. completely inhibited nitrite formation, .5 per cent. and .25 per cent. retarded and 0.1 per cent. had no detrimental effect.

Peptone, 1 per cent., in mineral salt medium temporarily checked nitrite formation, then active oxidation followed.

Free CO_2 from the air was necessary as the source of carbon. However that from the carbonate in the medium was sufficient to support a very slight oxidation.

Ammonium salts were used as a source of energy by the organism whenever available, except in one instance, when starch was added to the mineral salt medium.

Since this organism was in all the surface layers of soil tested in both North Carolina and Florida and formed nitrites between 55°-60° C., which is contrary to all findings reported, it is evidently a *new genus* and a *new species*. Considering this fact it seemed advisable to suggest a name. The name is *Nitrosobacillus thermophilus* Campbell (*Gen. et. sp. nov.*).

Eva Galbreath Campbell

Guilford College

MUSEUM TAGS OF CHEMICAL PROOF PAPER

A recurring problem in museum technique is offered by the necessity of numbering specimens preserved in alcohol, formalin, or other liquid. The use of metal tags for this purpose has been general, pure tin being by far the best material available. Metal tags are, however, subject to corrosion in formalin solutions or even in alcohol to which formalin specimens have been transferred. There is some difficulty in securing tin of uniformly pure composition, and even a slight impurity may greatly activate the process of corrosion.

The paper known as Dennison's fiber-proof paper, manufactured by the Dennison Manufacturing Company, Framingham, Massachusetts, was devised especially as a chemical-proof paper for laundry tags. I assume it to be a paper impregnated with albumin, which is subsequently hardened by treatment with formaldehyde. This paper comes in 20″ x 24″ sheets, somewhat variable in thickness. The lot now in use at Field Museum of Natural History is .346 mm thick. This paper does not soften in water, alcohol or formalin solution.

The 20″ x 24″ sheets, in our practice, are cut into ⅞″ strips. These are printed with rules set ¼″ apart on one side and the initials F.M.N.H. set exactly between the rules, on the other. Numbers are then stamped *into* the paper, to a depth of about half the thickness of the stock, by means of an automatic numbering machine, such as the one manufactured by W. A. Force and Company, Chicago. The printed rules serve as guides, so that the finished tag measures ¼″ x ⅞″. Those impressed numbers are then inked by hand with Higgins waterproof drawing ink, to increase the legibility of the numbers, and dried. The numbering machine perforates the strip opposite each number, and the numbered strips next have the strings attached. The individual tags are then cut from this strip as wanted.

The late Dr. Carl H. Eigenmann seems to have been the first to use this special paper for numbering museum specimens. Before deciding on its use in the Field Museum, Mr. Alfred C. Weed subjected sample tags to severe tests, such as boiling and shaking with stones; it was adopted by Mr. Weed and myself for the collections in our charge in 1922. It has since been adopted by the Museum of Comparative Zoology, the Museum of Vertebrate Zoology of the University of California, and the Museum of Zoology of the University of Oklahoma. No disadvantage has appeared during the nine years of our experience with this material.

The small, light, legible tags are of course especially suitable for small mammal skulls, to which they may remain attached while boiling.

KARL P. SCHMIDT
FIELD MUSEUM OF NATURAL HISTORY

SPECIAL ARTICLES

THE DISTRIBUTION OF EXTRA-GALACTIC NEBULAE

THE paper gives the results of an analysis of counts of nebulae on E-40 plates made by the writer with the 100-inch and 60-inch reflectors at Mount Wilson. About 20,000 nebulae were counted on 900 plates. Six hundred of the plates represent hour exposures on selected areas uniformly distributed in galactic coordinates over three-fourths of the sky (north of Dec. -30°). The remaining 300 plates, with exposures ranging from 20 min. to 3 hours, were for the most part centered on individual objects.

REDUCTIONS

The counts were reduced to a homogeneous system by corrections for quality (the better the definition the greater the number of small nebulae which could be distinguished from stars, etc.) and later for zenith distance. Plates with the two telescopes were first analyzed independently but were later combined by applying a mean factor to the 60-inch results. Corrections were also derived for reducing the actual counts to the number of nebulae per square degree (coma factor and area factor). These, however, were not used in the intercomparison of plates. Tabulation of the data and the detailed analysis will appear in a contribution from the Mt. Wilson observatory.

RESULTS

Results of the analysis are as follows:

(A) No nebulae are found in very low gulactic latitudes. The "zone of avoidance" is irregular and sinuous, the width ranging from 10° to 40°. It appears to represent the distribution of known obscuring clouds—a relatively narrow belt symmetrical to the galactic plane from which run out the great clouds in Taurus, Cassiopeia, Ophiuchus, etc. The inclined belt of bright B stars and diffuse nebulosity, reaching its highest latitudes in Taurus and Ophiuchus, respectively, is a conspicuous feature.

(B) The zone of avoidance is bordered by partial obscuration which extends out to latitudes ± 40° in the general direction of the center of the galactic system longitude 330° to 340°) but is very limited in the opposite direction except for the known obscuration below the Taurus region (long. 140° lat. -35° to -40°, balanced by the obscuring cloud at long. 330° lat. +35°).

(C) For latitudes greater than ± 40° (and in lower latitude in the direction of the anti-center) the distribution of the nebulae is approximately uniform, with occasional clusters scattered at wide intervals. The mean log N for an exposure of one hour with the 100-inch, 5 x 7 plate, definition excellent, zenith distance zero, is 1.74, corresponding to 2.375 for a square degree. This may be compared with log N = 2.036 per square degree for the 60-inch under similar conditions. The frequency distribution of the counts approximates an error curve with a probable error of the order of 0.15 in log N for a single plate. The extreme range is about 1.0 in log N, but this includes all accidental errors as well as actual deviations.

(D) In the region of normal distribution and for exposures ranging from 20 min. to 3 hours, the counts are correlated with the exposure times, and the correlation closely approximates that to be expected on the assumption that the nebulae are uniformly distributed in depth (tripling the exposure increases the limit of the plate one magnitude and quadruples the number of nebulae). The scatter about the correlation curve log N = 1.26 log E - 0.50 diminishes as the exposures increase. Data from other sources indicate that counts of brighter nebulae are fairly consistent with this correlation. Appreciable absorption of light in extra-galactic space appears to be inadmissible.

(E) The limiting magnitude for the counts on exposures of one hour with the 100-inch is estimated as 19.8, hence the number of nebulae per square degree is given by the relation

$$\log N_{sd} = 0.6\, m_{pg} - 9.5$$

This, combined with the value −13.8 for the mean absolute photographic magnitude of nebulae, leads to a mean density of the order of one nebulae per 6×10^{16} cubic parsecs. A provisional value for the mean mass of nebulae, 5×10^{8} times the mass of the sun, suggests 5×10^{-31} gm/c.c. as the order of the mean density of nebular material in the observable region of space.

(F) The scanty data available suggest that, in the regions of normal distribution, one cluster of nebulae which would be recognized as such on exposures of one hour, may be expected per 30 square degrees. This frequency is tentative and depends largely upon the criteria selected for defining a cluster.

The distribution of nebulae appears to be approximately uniform out to the limits of the largest telescope available, except in so far as it is affected by partial or complete obscuration by diffuse material within the galactic system. Great clouds of the latter material are known to exist; in fact, the pattern of obscuration along the Milky Way seems to account for many or most of the "star clouds." Evidence from the nebulae concerning a uniformly diffused substratum within our own system is contradictory. In favor of the hypothesis is the fact that, in the general direction of the center, the counts of nebulae are affected out to latitudes ± 40°, the occasional late type spirals in low latitudes with abnormally faint surface brightness; and the color-excess exhibited by members of the Perseus cluster of nebulae at lat. −13°. For these facts a diffuse substratum offers a possible although not a necessary explanation. Against the hypothesis are the approximately normal colors among nebulae in low latitudes and longitudes 10° to 50°, the normal surface brightness of late type spirals in the same region at latitudes as small as 8°, and the fact that for the 8 nebulae within 20° of the galactic plane whose spectra are available, the absolute magnitudes corresponding to distances indicated by the red shifts average brighter than normal. Extensive observations will be required for a definite conclusion. Obscuring clouds are familiar, but a diffuse substratum can be investigated only when the effects of the clouds can be ascertained and eliminated.

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THE HEMOGLOBIN CONTENT OF THE BLOOD OF THE HEN: A STATISTICAL STUDY OF INFLUENCES AND RELATIONS

IN another communication[1] results were presented of a study of the hemoglobin content of the blood of chickens and wild fowls. The method of hemoglobin determination was that of Newcomer. A correction was introduced for at least the greater part of the turbidity of the acid hematin solutions prepared from bird blood for hemoglobin determination by the Newcomer method. The correction formula is

$$C = 0.91U - 1.49,$$

where C is the corrected reading and U the uncorrected reading.

Table 1 shows the hemoglobin content of the blood of the hens and the pullets studied.

TABLE 1

MEAN HEMOGLOBIN CONTENT OF THE BLOOD OF HENS AND PULLETS

	Number of individuals	Uncorrected hemoglobin	Corrected hemoglobin
		gm per 100 cc	*gm per 100 cc*
White Leghorn hens	101	12.8 ± 1.0	10.2 ± 0.9
White Plymouth Rock hens	101	12.3 ± 0.8	9.8 ± 0.7
Rhode Island Red hens	102	11.9 ± 0.7	9.4 ± 0.7
White Leghorn pullets	101	11.4 ± 0.7	8.9 ± 0.7

The data in this table indicate breed differences, and one purpose of this paper is to present the results of a statistical study made to determine if such differences are significant.

Since data on the age of the birds at the time of making the hemoglobin measurements, on the age at maturity and on the spring egg production were available through the cooperation of the College Poultry Husbandry Department and the dates of making the hemoglobin measurements were known, it was deemed worth while to make a statistical study of the correlation between hemoglobin and these different factors. A presentation of these results is the second purpose of this paper.

For the purposes of this statistical study it is immaterial whether corrected or uncorrected hemoglobin readings be used. The latter readings are used in all instances.

The statistical constants were calculated according to the method given by Wallace and Snedecor.[2]

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[1] H. H. Dukes and L. H. Schwarte, *Amer. Jour. Physiol.*, 96: 89–93, 1931.

[2] H. A. Wallace and G. W. Snedecor, "Correlation and Machine Calculation," Official Publication, revised edition. Iowa State College, Ames, Iowa, 1931.

INFLUENCE OF BREED

The mean hemoglobin content of the blood of the hens of various breeds is shown in Table 1. In Table 2 are shown the mean differences in hemoglobin content by breeds, the probable errors of the mean differences and the ratios of mean differences to probable errors. The mean differences by breed are uncorrected for age and age at maturity. It will be noted that all the differences are statistically significant.

TABLE 2

DIFFERENCES BY BREED IN THE MEAN HEMOGLOBIN CONTENT OF THE BLOOD OF HENS

	Rhode Island Red hens			White Plymouth Rock hens		
	Mean Hb difference	PE	Ratio	Mean Hb difference	PE	Ratio
	gm per 100 cc			*gm per 100 cc*		
White Leghorn hens	0.9	0.12	7 +	0.5	0.12	4 +
Rhode Island Red hens				0.4	0.11	3 +

When the mean differences shown in Table 2 are corrected for age and age at maturity, they are still found to be significant.

INFLUENCE OF AGE

The hemoglobin content of the blood of chicks is between six and seven gm per 100 cc.[3] Evidently at this period in the life of the chicken age has a considerable influence on the hemoglobin content of the blood.

The mean hemoglobin content of the blood of White Leghorn pullets ranging in age from about four to six months is 11.4 ± 0.7 gm per 100 cc. The mean of White Leghorn hens is 12.8 ± 1.0 gm per 100 cc (Table 1). The difference is 1.4 ± 0.12 gm per 100 cc, which is highly significant. The data also furnish information on the influence of age on the hemoglobin content of the blood of hens. The mean age of all hens was 658 ± 10 days; the mean hemoglobin content of the blood, 12.3 ± 0.1 gm per 100 cc. The correlation between age and hemoglobin was found to be 0.21. The number of hens included in this study is approximately 300. With a number as large as this a correlation coefficient of 0.21 is, according to Fisher's tables,[2] highly significant.

CORRELATION BETWEEN SEASON AND HEMOGLOBIN CONTENT

There is a wide-spread popular belief that the blood of animals is "thicker" in the winter than in the summer. Furthermore, there is a good deal of evidence[4] tending to show that external heat causes a dilution of the blood. The present data are suggestive in this connection, in that they indicate that with the approach of winter the hemoglobin content of the blood increased significantly. Thus the mean date of the hemoglobin determinations in hens was 39.4 ± 0.25 weeks after January 1, that is, the second week of October; and the correlation between the date of determination (season) and the hemoglobin content of the blood was found to be 0.20.

CORRELATION BETWEEN AGE AT MATURITY AND HEMOGLOBIN CONTENT

The mean age of all hens at maturity (date of laying first egg) was 207 ± 2.0 days. The correlation between age at maturity and the hemoglobin content of the blood was found to be – 0.16, which also is highly significant.

CORRELATION BETWEEN SPRING EGG PRODUCTION AND HEMOGLOBIN CONTENT

Since spring egg production is a part of yearly egg production, these show a high positive correlation. Therefore a determination of the correlation between spring egg production and the hemoglobin content of the blood would give information about the correlation between the annual egg production and hemoglobin.

The mean production of all hens for the spring of 1929 was 59 ± 1.0 eggs. The correlation between spring egg production and the hemoglobin content of the blood was found to be 0.08, which is not significant.

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SCIENCE

VOL. 75 FRIDAY, JANUARY 8, 1932 No. 1932

The American Association for the Advancement of Science:
  Astronomy's Contribution to the Stream of Human Thought: PRESIDENT D. W. MOREHOUSE 27
  The Physiology of Consciousness: PROFESSOR EDWIN G. BORING 32
Scientific Events:
  The Master's Degree for Postgraduate Students in the Medical School of Columbia University; Further Investigation of Cosmic Rays; Presentation of The Perkin Medal to Dr. Burgess; Officers of the American Association for the Advancement of Science 39
Scientific Notes and News 42
Discussion:
  A Theory of Disinfection: DR. M. L. ISAACS. *The Cotton Root Rot Fungus Indigenous in Arizona Deserts:* C. J. KING, CLAUDE HOPE and E. D. EATON. *Is Evolution only a Detail in the Dynamics of Populations?:* DR. JOHN STANLEY. *The Growth of Stalactites:* DR. GRAGG RICHARDS 46
Special Correspondence:
  Field Anthropology in Australia: J. B. CLELAND 50
Scientific Apparatus and Laboratory Methods:
  Concentrating Paramecium and Rotifers without Centrifuging: PROFESSOR EDGAR P. JONES. *A Simple Photomicrographic Apparatus for Obtaining Depth or Focus:* BRANDON H. GROVE 52
Special Articles:
  Chemical Studies on Toad Poisons, IV, Bufagin and Cinobufagin: DR. H. JENSEN. *Cryolysis of Lyophilic Colloids, and its Bearing on the Mechanism of Enzyme Action:* DR. F. F. NORD and O. M. VON RANKE-ABONYI. *Sex Differences in the Study of General Science:* VICTOR C. SMITH. *Progress in Western Duck Sickness Studies:* E. R. KALMBACH 53
Science News 10

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ASTRONOMY'S CONTRIBUTION TO THE STREAM OF HUMAN THOUGHT[1]

By President D. W. MOREHOUSE
DRAKE UNIVERSITY

> Contemplated as one grand whole, Astronomy is the most beautiful monument of the human mind, the noblest record of its intelligence.—*Laplace.*

THE development of human thought frequently has been compared with the formation of a great river. No single source can be named as the origin. Numerous streams from wholly different sources flowing in diametrically opposite directions converge to give it being. Not infrequently it is difficult to determine which is the main stream and which is the tributary.

The changes in its course can not be detected from up-stream. It turns back upon itself at the most unexpected moment and winds in and out among barriers which for the moment seem absolutely insurmountable. As it widens, it becomes shallow and its banks less distinct until new accretions cut deep gorges in the rocks of ignorance. Spring floods, too, have their analogy in the stream of thought. Samuel Butler's warning in Erewhon, "Woe to him who tampers with the banks while the flood is flowing," has been exemplified too frequently in astronomy.

COSMOLOGY

As the various races emerge from their primitive concepts of cosmology, we find some far in advance of others. For example, the Hebrews and the Greeks have been held up to us from time immemorial as the greatest peoples of their time. The Hebrews excelled in their conception of the things of the spirit, and the Greeks in art, science and philosophy. The Hebrews, having little interest in science, disentangled religion from pseudo-science and crude materialism. The Greeks, with their transcendent genius, founded science on actual observations and based their theories on facts.

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[1] Address of the retiring vice-president and chairman of Section D—Astronomy, American Association for the Advancement of Science, New Orleans, December, 1931.

Among the names of antiquity, Thales, Pythagoras, Menton, Aristotle and Plato, one Eudoxus stands out above all others. In point of time, Eudoxus lived 409–356 B. C. He, therefore, touched the life of Plato in his later years and that of Aristotle in his early days. Eudoxus is considered the first inductive thinker of his time. Berry says, "He may be regarded as representative of the transition from speculative to scientific astronomy, and much of his work was taken bodily by Aristotle, who, in common with other philosophers of his time, understood the influence of the concept of the physical world upon the thinking of the times.

Claudius Ptolemaeus

(100–170 A. D.)

The next important addition to the development of thought, after the coming of Christ, was started by Claudius Ptolemaeus, commonly known as Ptolemy. He was the propagator, if not the author, of the first cosmic theory of the universe, popularly known as the geocentric theory. The influence of this man is shown in the greatest work of antiquity, "The Almagest." If any one will wade through its thirteen books, he will find in them the cosmology and the cosmogony of his age. He will not only find the concepts of life, but also the ideas of eternity. There is an air of finality to this book which is not found in any other work of this time. It seemed to predict that the days of science had come to an end. As MacPherson points out:

> The Hellenic culture had largely exhausted itself and an air of hopelessness and futility had settled over the world. The Stoics rather concerned themselves with problems of conduct than with questions concerning the natural world, while the early Christians, expecting the early return of Christ, did not busy themselves with the affairs of this world. Accordingly, slowly but surely, science and philosophy alike seemed to die out.

During the next fourteen centuries, the Arabs, who were largely imitators and commenters rather than investigators, carried on the slender stream of scientific thought.

Nicolaus Copernicus

(1473–1543)

Every stimulus to the intelligence naturally brings with it a tendency toward inquiry into opinions received through tradition and based on some great authority.

Toward the end of the fifteenth century, astronomy again added a new stream to human thought through the labors of the celebrated Polish astronomer, Copernicus, of whom Thomas Digges wrote:

> But in this our age, one rare witte (seeing the continuall errors that from time to time more and more continually have been discovered, besides the infinite absurdities in their Theoricks, which they have been forced to admit that would not confesse any Mobilitie in the ball of the Earth) hath by long studye, paynfull practise, and rare invention delivered a new Theorick or Model of the world, shewing that the Earth resteth not in the Center of the whole world or globe of elements, which encircled and enclosed in the Moone's orbit, and together with the whole globe of mortality is carried yearly round about the Sunne, which like a king in the middest of all, rayneth and giveth laws of motion to all the rest, spaerically dispersing his glorious beames of light through all this sacred coelestiall Temple.

The life of Copernicus was quite uneventful. He has been dubbed by nearly every writer as a plodder, and yet, no other one thing has so completely changed the trend of human thought as his bold statement that the earth is not the center of the solar system. From the earliest time, the geocentric idea of the universe had held sway. It is quite true that here and there a few lone figures suggested the possibility of another concept, but they were quickly stifled, and the earth and man restored to their position—the end and aim of creation.

One can hardly imagine the profound influence on the thought of the time of Copernicus' great book "The Revolution of the Celestial Bodies," setting forth the new order of things. To some it may seem a pity, to others, a blessing that he did not survive the publication of his book in 1543. At first, it was treated with the utmost contempt by authorities and with furious vindictiveness by theologians. We must remember that at this time the Reformation was at its height; Protestantism and Catholicism were in a titanic struggle with each other; Luther had pinned his theses to the church door, and yet that great Protestant was among the first and most vehement to denounce the Copernican system. He referred to Copernicus as "an upstart astrologer who strove to show that the earth revolved." "This fool," said Luther, "wishes to reverse the entire science of astronomy, but sacred scripture tells us that 'Joshua commanded the sun to stand still' and not the earth." Says Andrew D. White in "A History of the Warfare of Science with Theology in Christendom":

> While Lutheranism was thus condemning the theory of the earth's movement, Calvin in his "Commentary on Genesis" was condemning all who asserted that the earth is not at the center of the universe. He clinched the matter by the usual reference to the first verse of the ninety-third Psalm, and asked, "Who will venture to place the authority of Copernicus above that of the Holy Scripture?"

Suggestions were heard on every side that such views should be forcibly repressed, and some of its advocates, for example, Bruno, were condemned to death and burned at the stake in 1600. As history records, the second martyr of the Jesuits was harassed and persecuted solely for his adherence to the Copernican system.

> The greatness of Copernicus, [quoting from MacPherson] is not to be measured by what he did, but by what he made possible. A vast extent of the universe was revealed, and so the philosophic and theological outlook was vitally affected by the new system. While the scholastics were vainly trying to refute Copernicanism and the theologians were engaged in hurling anathemas at the heads of its supporters, the new system of the world was being established upon a firm scientific basis.

THE CONCEPT OF DYNAMICS

Bacon pointed out at a distance the road to true philosophy: Galileo both pointed it out to others and made himself considerable advances in it.—*David Hume.*

The century following the death of Copernicus produced three great men of remarkable genius, Tycho Brahe (1546–1601), Kepler (1571–1630) and Galileo (1564–1642), an observer, a mathematician and a physicist. Kepler, who devoted a lifetime to the discovery of the three laws of planetary motion, which bear his name, did not conceive of their dynamical explanation. MacMillan says:

> He was content to ascribe them to the intelligence of an angel who guided the planets in their courses. His was the age of spirits and Kepler's interpretation of uniformities was Animistic. The foundations of dynamics came only with the genius of Galileo, who had little liking for the conceptions of Animism. His *induction* that the natural state of a body was uniform motion in a straight line, and that a departure from that state was due only to force was one of those great breaks with the Past which occur at rare intervals in human history and which have raised the race of men to its present intellectual level. Galileo initiated a new age, the one in which we live, the age of dynamics.

It was the work of Galileo, in his discovery of the revolution and phases of planets, that completely confirmed the Copernican doctrine. Father Inchofer of the Jesuits in denouncing him declared:

> The opinion of the earth's motion is of all heresy the most abominable, the most pernicious, the most scandalous. The immovability of the earth is thrice sacred. Argument against the immortality of the soul, the existence of God, and the incarnation should be tolerated sooner than the argument to prove that the earth moves.

Thus the controversy went on. The very thought of the earth as no longer the center of the universe was the real crux in the situation. If the Copernican system was true, then the entire outlook of human thought was changed, and the old, time-honored cosmology must be discarded. As the earth had lost its position among the heavenly bodies, so man would necessarily lose his supremacy in creation, and endless problems presented themselves.

CONCEPTS OF MECHANICS

Sir Isaac Newton—The Great Mechanist

(1642–1727)

Nature and Nature's laws lay hid in night
God said, "Let Newton be" and all was light.

Newton completed the work of these men and established the fundamental principles of Mechanics in the "Principia" which, as Laplace has declared, "has a preeminence over all productions of the human intellect." Says Andrew D. White:

> There came, one after another, five of the greatest men our race has produced—Copernicus, Kepler, Galileo, Descartes and Newton—and when their work was done, the old theological concept of the universe was gone. "The spacious firmament on high"—"The crystalline spheres"—"The Almighty enthroned upon the circle of the heavens" and with His own hands or with angels as his agents keeping the sun, moon and planets in motion for the benefit of the earth, opening and closing "the windows of heaven," letting down upon the earth "the waters above the firmament," "setting His bow in the cloud," "handing out signs and wonders," hurling comets, casting forth lightning to scare the wicked, and shaking the earth in His wrath: all this had disappeared.

The Newtonian theory was the natural outgrowth of the Copernican theory and had no less influence upon human thought. The old idea of celestial and terrestrial differences had been positively refuted. The solar system had been discovered. It was now clear that the fixed and law-abiding order of nature prevails not only upon this earth but also throughout the universe. Thus we have the beginning of mechanism—the whole universe reduced to a machine.

Quite contrary to the reception of the Copernican system, this thought was quickly grasped by the theologians. They had here from a profound scientist just what they had been looking for—a perfect system ruled over by a carpenter God. For Newton, in his perfect order of things, proves the existence of a God; an idea which drew from Leibnitz the criticism that "Newton had compared the universe to a clock which required the constant interference of the clockmaker."

Here we find a splendid basis for Deism. Many of the great men of England seized upon this idea and appropriated it to their uses. Through the writings of Ferguson, Paley and Thomas Dick, the mechanistic conception of the universe had a profound influence on human thought and prepared the way for Deism by commending it to the rational faculties. It was Laplace who cried out in protest to this great wave, "I have no need of the hypothesis of a God."

Sir William Herschel, The Artist
(1738–1822)

Coelorum perrupit claustra—*Herschel's Epitaph.*

> Was it a dream?—that crowded concert-room
> In Bath; that sea of ruffles and laced coats;
> And William Herschel, in his powdered wig,
> Waiting upon the platform, to conduct
> His choir and Linley's orchestra?
> He stood
> Tapping his music-rest; lost in his own thoughts.
> —*Alfred Noyes.*

The century that intervened between Newton and Herschel was probably more productive from the standpoint of human knowledge than any other like period. More great scientists and mathematicians arose during this interval than in any other corresponding time in human history. Time will not permit me to speak of the work of such men as Halley, Clairaut, Bradley, Euler, Lagrange, Laplace and Gauss.

They developed the greatest science ever conceived by the human mind, celestial mechanics. In the words of MacMillan, "They erected a monument to the human intellect that can never be forgotten as long as the mathematical faculties of men are active."

Undoubtedly these men lost much of their luster by suffering comparison with Newton. Stars, they were, of the first magnitude, but you can not see a star when the sun is shining.

Such was the condition of the astronomical world when the itinerant musician, Frederick William Herschel, made his way to Britannia: The sole aim of astronomers was the verification of the Newtonian theory, and human thought was completely centered on the solar system. The stars were merely guide-posts from which to take measurements and with which to compare results. What a discouraging situation for an artist! But Herschel was equal to the task which confronted him. By his artistry he transformed the humble guide-posts into monuments of surpassing splendor, by demonstrating what other observers had suggested as probable, "The essential kinship of the sun with the stars." By his observation of double stars, he extended the law of gravitation to the sidereal universe. As MacPherson points out:

> Copernicus had shown that the earth, so far from being the center of the universe, was but one planet among others in ceaseless revolution around the sun. Herschel now proved that the sun itself was not the central body, but was merely one star among others in ceaseless motion through the depths of space. Newton had shown that the solar system was subject to one law, and Herschel demonstrated that this same law was applicable to the stellar system.

Thus we have the beginning of a new concept, cosmology, or the extension of the universe to a sidereal system. This required new postulates which had never been conceived, let alone proved, and endless observations which had not been made. As before pointed out, everything had been confined to the solar system. Now we must have a new type of observations and an expansion of thought.

The sky was vast and the equipment at hand was meager, but Herschel met both challenges, constructed his own instruments and made a careful survey of the entire sky in duplicate. As a result of his observations, he first formulated the disc or grindstone theory of the stellar system, which he later abandoned, but left his vast store of data to his successors. He was convinced, however, that the Galaxy or Milky Way is a greater system of which the solar system is a mere atom. His theory "that star clusters and nebulae formed universes external to our galaxy" implied an immense extension of the universe not only in space, but in time. As he said, "I have looked farther into space than ever human being did before me," adding more hypothetically, "I have observed stars of which the light, it can be proved, must take two millions of years to reach the earth." What an influence such ideas must have had on contemporary thought is suggested by Horace Walpole in his well-known expression, "One's imagination cracks."

COSMOGONY

The greater the sphere of our knowledge, the larger is the surface of its contact with the infinity of our ignorance.—*Anonymous.*

The ancients generally did not clearly distinguish between cosmology and cosmogony. "There had been implanted," says Andrew D. White, "along through the ages, germs of another growth in human thinking; some of them even as early as the Babylonian period. In the Assyrian inscriptions we find recorded the Chaldeo-Babylonian idea of an evolution of the universe out of the primeval flood or great deep." This thought was adopted by their neighbors, the Hebrews, but was soon stifled by the more powerful influence of their inherited doctrine. The Ionian school developed the idea more clearly. Anaximander, for instance, conceived of the visible universe as the result of evolution, and Aristotle carried it to a point which approached modern views. Notwithstanding the work of these men, the idea of creation in six literal days predominated in the minds of the masses for hundreds of years.

Probably the first great factor that influenced the church to accept these new doctrines was the work of Ralph Cudworth in his "Intellectual System of the Universe," published in 1698. He argued most effectively against the prevailing mechanical theory and set forth the idea of a divine imminence in both theology and science. He says:

> Nevertheless, the substance or matter out of which the world was made was not itself made but always ready at hand, and subject to the artificer, to be ordered and disposed by him. For the making of the world was not the production of it out of nothing, but out of an antecedent, bad and disorderly state, like the making of a house, garment or statue.

It seems extremely difficult to locate the first idea of a nebular hypothesis. The Scottish astronomer, James Ferguson, strongly suggested the idea in the following sentence:

> In the beginning God brought all the particles of matter into being in those parts of open space where the sun and planets were to be found, and endowed each particle with an active power by which these neighboring and at first detached particles would in time come together in their respective parts of space and would form the different parts of the solar system.

History gives the credit of the nebular hypothesis to Wright, Kant, Laplace and Herschel. The first two developed it theoretically and from a deductive point of view. They postulated nebulae out of which solar systems evolved. Their ideas were wholly speculative. Herschel showed by direct observation that there are nebulae and was the first to develop the hypothesis by inductive methods. We know that the nebular hypothesis was received very calmly at first. There were a few outcries against it, but Laplace published it only as a speculative theory; an appendix to his "Celestial Mechanics," and Herschel did not publish his ideas except in scientific papers of the Royal Society, which were not read by the masses. The opposition from the theologians was not more vigorous than from most scientists. The exact nature of a nebula was not known. The question arose as to the difference between nebulae and star clusters. Was it simply a case of optical power of resolution? And again science halted for a time.

From an unexpected source came a new factor, the spectroscope which had no less an influence upon the time than had the telescope of Galileo. Fraunhofer, about the beginning of the nineteenth century, showed that there is an intrinsic difference between a gas and a solid. Immediately his principles were applied to the nebulae and they were found to be gaseous. "As a result," says MacPherson, "The chemical unity of the universe was found to be a truth of nature. The cosmos was seen to be in very truth a cosmos connected and interrelated in all its parts." Quoting further, he says:

> Slowly but surely the mechanical theory was passing away. Even in theology, Deism was giving place to the new sense. In philosophy, the empiricism of the French school was giving way before the idealism of Fichte, Schelling, Hegel and Goethe. And in physics, the whole mechanical concept of empty space and isolated bodies was disappearing.

As expressed by Charles N. Holmes, the universe began to expand before man:

> Above him yawn (ed) abysmal gulfs of space!
> Mysterious, majestic, silent, cold
> Ablaze with stars that shone upon our race
> When Joseph by his relatives was sold,
> Before him loom (ed) the sky like scroll unroll'd,
> Inscribed with symbols gleaming brilliantly,
> Far, far remote, yet those that furthest be
> Reveal no limits save Infinity.

A new problem now arose: What is the form and extent of our universe? If we accept the Copernican or heliocentric theory of our solar system, then what is our concept of the stellar system? The great galaxy or "Milky Way" suggests the existence of two streams of stars, or a spiral nebula, and the work of Kapteyn, Campbell, Shapley, Russell and Hubble, not to mention others, has gone far to establish it as a truth. The idea of "island galaxies" is again coming into favor. "This theory," says Eddington, "is much to be preferred as a working hypothesis, and its consequences are so helpful as to suggest a distinct probability of its truth." In the chemical and physical world we start with the electron as a unit from which we build the atom, then the molecule and finally the ordinary mass. In the cosmic universe the solar systems are the atoms with their planetary electrons. The star clouds and clusters are cosmic materials composed of solar systems, and the galaxies are aggregations of stellar and nebular masses. Says MacMillan:

> It will be observed that ordinary masses are just in the center of our list of physical units. Shall we go back to the old notion that we are the natural center of the universe, or shall we regard this as a mere appearance, due to the fact that it is more and more difficult for us to have experience with those units which are more and more remote from us in the physical scale? We are at the center, because the center is everywhere. Two atoms of gold seem just alike because we are not very familiar with atoms of gold, and two electrons seem to be identical merely because of our profound ignorance. Supergalaxies exist though we have had no experience with them at all; likewise, hypersupergalaxies, and so on indefinitely. Things do not cease to exist merely because we are ignorant. We should beware of the tacit postulate, which often crops out, ''Only those things exist with which we have had experience.'' Nature is much broader than experience, and we must have plenty of room for expansion.

During the nineteenth century cosmogony has been in the hands of an able group of mathematicians, physicists, geologists and astronomers, among whom should be mentioned Moulton, MacMillan, Chamberlin, Kapteyn, Sears, Russell, Shapley, Jeans, Eddington, deSitter and Einstein. The old ring theory of Laplace has been rigorously attacked and found wanting in many of its details. We now have a new idea under the caption of the planetesimal hypothesis in which the modern concepts of dynamics and the structure of matter play an equally important rôle with mathematics. Geology is no longer ignored. The invention and application of the interferometer has verified and greatly extended the postulated sizes and distances of the stars. The new one hundred inch Hooker telescope is resolving and analyzing the star clusters and nebulae in a manner wholly undreamed of a half century ago.

The two solutions of Einstein's fundamental equations, resulting in a finite, static universe as one extreme and an infinite, expanding universe as the other, give promise of a more general solution approaching objective reality. We must not be misled by the first solutions of so difficult a problem. As often happens in pure mathematics, the special cases are the first to appear, then the more generic gradually evolve.

The size and shape of the universe is probably no more impossible of solution to-day than the size and shape of the solar system was in Ptolemy's day. To our finite minds a universe that requires a beam of light five hundred thousand million light years to circumnavigate it is infinite, but as Sir James Jeans says, "We are not terrified by the sizes of the structures which our own thoughts create, nor by those that others imagine and describe to us. The immensity of the universe becomes a matter of satisfaction rather than awe; we are citizens of no mean city. Again, we need not puzzle over the finiteness of space; we feel no curiosity as to what lies beyond the four walls which bound our vision in a dream."

Schiaparelli once called astronomy the science of infinity and eternity and the description is just. "These words," says MacPherson, "are often used by philosophers and theologians. Astronomy gives some definite sense of what they mean. The concepts of infinity and eternity are soul-staggering, but they are less difficult than those of limitation of space and time. To the higher thought, the chief contribution of modern astronomy is doubtless this sense of the infinity of space and the eternity of time."

THE PHYSIOLOGY OF CONSCIOUSNESS[1]

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MY thesis this evening is that scientific psychology needs more than to become the physiological psychology that Wundt originally called it, and that we are not entirely without the means of proceeding in this direction. Psychology, it seems to me, needs to save for its own uses both consciousness and the nervous system, and it must have both if it is to survive.

Once upon a time psychology had some hope of getting along without a nervous system. There was a time when introspectionists, like Külpe and Titchener, would have hailed with avidity any step that brought psychology nearer to being a descriptive science of the facts of experience, a science that could get along with introspection as its only method and could leave the nervous system and the stimulus ruthlessly in the outer darkness of physiology. There is no need to explain to this audience that the introspective method unsupported failed to yield a psychology, or perhaps even a single factual generalization.[2] The most satisfactory introspective experiments were those that resulted in the correlation of sensory or perceptual data with stimulus. The best theories were formulated in terms of the nervous system or the sense-organs. Unaided introspection proved inadequate in crucial cases, as in the problem of thought where we were left with only a "physiological" determining tendency as a principle of explanation.

The reaction of behaviorism against this state of affairs by the complete rejection of the introspective method was very natural, even though it represented a throwing out of the baby with the bath. Theoretically you can answer for animals, by tests of discrimination or by observation of conditioned reflexes, any of the questions about sensory or perceptual capacities that have been answered for human beings by the use of the introspective method. And what can be done with animals in general can be done with human animals. Nevertheless, the behavioristic method is not always advantageous. Sometimes it yields results that are less univocal than those gotten by an introspective method.[3] Sometimes it is terribly laborious and no added precision is gained for the added pains. If you will imagine a behavioristic method which determines, without the use of words, the occurrence of difference tones, or the wave-length of one of the three pure spectral colors, you will see what I mean when I say that these objective methods can be clumsy.[4]

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[1] Address of the retiring vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, New Orleans, December 29, 1931.

[2] There never were any laws of introspective psychology other than those that state the correlation of conscious processes with the stimulus or with events in the nervous system, with the possible exception only of the law of association. Now-a-days it is superfluous to claim that association is solely a law of conscious events, when we are so constantly being reminded of its physiological counterpart, the conditioned reflex.

It is worth noting that behaviorism owes its *ism* to consciousness. And what would it be without its *ism?* Well, it would be physiology. Behaviorism has preserved itself as psychology and as something that is not physiology—I speak of the historical fact, whatever may have been the wishes of the behaviorists—by persistently attempting to solve the problems that originated as introspective problems of the psychology of consciousness. The attitude of the behaviorist for introspection has always been ambivalent. He has hated introspection for the love he bore it.

On the other hand, if we bring consciousness back into "physiological psychology," without ridding ourselves of the old-fashioned Cartesian dualism, we get no farther along than we have always been. Now there is nothing new in my objecting to dualism. Perhaps the majority of you had thought of dualism as already rooted out of psychology. Nevertheless, you see that the behaviorist, who would have us ignore consciousness in psychology, is thereby a dualist because he has to believe in consciousness as something different from the "objective" world in order to dismiss it as irrelevant. In this way behaviorism has often emphasized the fundamental dichotomy of mind and body by its insistence that the mind is not the body, and that you may take the one and leave the other. *Gestalt* psychology certainly has no use for dualism, and yet it is impossible to read Köhler[5] or Koffka[6] on the correspondence of "direct experience" to "underlying physiological processes" without feeling that the old dichotomy is still fundamental to their thought. The step I am asking you to take, in the interests of getting to a physiology of consciousness, is ever so much more radical than these imperfect attempts to avoid the Cartesian curse: I am asking you utterly to abandon dualism, sincerely, so that if there be a consciousness that could be ignored you will let it into the total system that is your scientific monism.

It is the introspectionists who have been primarily at fault in this matter. Wundt talked about "immediate experience," and Köhler talks about "direct experience." In such phrases there is an implication that there is some way of taking hold of experience, immediately, just as it is *per se,* and of keeping it for scientific purposes, and that in doing so one has introspection. Physical science is supposed to deal with entities that are mediate to experience, to be indirect in the sense that its subject-matter consists of inferential "constructs." The formula that Külpe and Titchener took from Avenarius, that psychology deals with all experience regarded as dependent upon the experiencing individual, is really not so much different, because experience really is dependent upon an experiencing individual for its existence, and when so regarded is thus being taken more immediately, more in its own right rather than as a ground for inference. I am quite serious when I say that this view of introspection seems to me to be nonsensical. The view implies that there is nothing important to introspection, that to have an experience is the same as to be aware of having it, that observation of conscious processes is nothing other than being conscious.[7]

However, the difficulty of regarding "direct experience" as the subject-matter of any science becomes more apparent when we note that we are landed by it in a circle of dependencies. At one time those who hold to this view will tell you that there is experience from which all science is derived, that psychology deals immediately with experience, and that the materials of physical science are mediately derived from experience. The view seems to make psychology prior to all the other sciences. Thus Köhler tries to prove that behaviorism is really introspectional because its data were originally experiential.[8] Nevertheless, these introspectionists may at another time hold to the opposite point of view that experience is dependent upon the activity of a brain or a nervous system. "No psychosis without neurosis" used to be the phrase. What then have we?

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[3] On the behavioristic method as more equivocal than the introspective method in the determination of the two-point limen, see E. G. Boring, "The Stimulus-Error," *Amer. J. Psychol.,* vol. 32, pp. 449–471, 1921.

[4] *Cf.* the awkward (imaginary) experiment that J. B. Watson describes for the determination of difference tones, "Psychology from the Standpoint of a Behaviorist," Philadelphia, 1919, p. 78 (same in 2nd ed.). I have forgotten who it was in the Harvard Psychological Colloquium who suggested that an animal could be tested for *Hauptfarben* in the following manner. If one is after the wave-length for pure yellow, one would train the animal to respond positively to the yellower of two oranges, and would see how far along the spectrum this relational response would be given. Obviously, it should break down at the pure yellow, since a yellow-green is not yellower than a yellow.

[5] *Cf.* W. Köhler, "Gestalt Psychology," N. Y., 1929.

[6] *Cf.* K. Koffka, "Some Problems of Space Perception," in "Psychologies of 1930," pp. 161–187, Worcester, Mass., 1930.

[7] Philosophers have made this same objection, but introspectionists have found little force in it ever since the argument for immediacy was put so trenchantly by E. Mach, "Analyse der Empfindungen," 1886, *et seq.,* and Eng. trans.

[8] Köhler, *op. cit.,* pp. 3–69.

We have first the assertion that the brain, a physical entity, is a "construct," like an atom or an electron, which is not as such given in experience but which may be regarded as real, and as generated from experience in the way that all scientific realities issue out of experience. In this sense the brain is dependent upon experience. However, in another sense experience must be considered as dependent upon the brain. To have each dependent upon the other is not a relationship that is going to help us much. Either dependency alone is valuable, but the two negate each other.[9]

On the other hand, we avoid this circle at once if we admit that psychology is not peculiar among the sciences, that introspection is as much a method as any of the other methods of observation, that it is a method whereby on the basis of experience we establish the existence or occurrence of mental "realities," like sensations or seen movements or any of the other phenomenal objects which introspection yields. The old fashioned introspectionist will not like my calling a sensation a "mental object," but I mean that it is as much an object as ever a molecule is a physical "object." Certainly the sensation as such is not given in experience itself.

If any of you doubt this statement, you have only to think how science is always proceeding by indirection. It uses experience, yes; but always as symbolic of something else. The behaviorist misses this point when he tries to make behavioral observation more immediate than introspective. Watson said that introspection is verbal behavior, as if there were some virtue in preferring the immediate datum that the experimenter observes, the spoken words, to the conscious processes signified. The behaviorist who uses "objective" methods of recording is just as indirect as the introspectionist: the immediate datum may be a kymograph record, yet it is for him merely a symbol of behavior.

Now, at last, I come to the main issue of this paper, my thesis that *introspection is a method for the observation of certain events in the brain.* Traditional introspectionism would protest such a statement. If I see a red circle, it would say that I am not seeing the brain; no part of the brain is red, presumably no event in it is circular. Nevertheless, I may be observing the brain, just as I can observe animal behavior by looking at records from a kymograph, or as I can observe an electric current by looking at the black and white pattern which is a pointer on the scale of a galvanometer. In scientific observation we always come face to face with symbols, and usually we ignore the symbols and talk about the realities that they signify.

Such a symbolic function of introspection may, of course, be sound epistemologically and yet utterly wrong. A relationship of this kind either does, or does not, grow in the structure of a science. We can not force its acceptance by argument. All we can do is to find it implicit in thought and to bring it out into the open. Even when it is exhibited and accepted by every one, it remains as tentative and temporary as does all scientific truth. It is our task, therefore, to consider the extent to which this view has already found its way into psychological research and whether it has seemed to be thus far successful.

We can best understand what has been going on within psychology if we return to the dualistic tradition, and see that in it there were, roughly speaking, three principal loci for psychological events: (1) the sense-organs, (2) the central nervous system and (3) consciousness. The three are causally related: stimulation of the sense-organ gives rise to a central neural process, which in turn may be said to "cause" a conscious process. In the less exact parlance of the laboratory, we are always thinking about stimulus, brain and consciousness.

The events in the brain, the middle term of this dependent series, have been largely inaccessible to observation. There has been of course some extremely important "direct" experimentation, from Fritsch and Hitzig to Lashley. There has been clinical observation. The rest of what we "know" about the brain is at a higher inferential level. The physiologist holds to the faith that the brain, being made up of neurons, is capable only of that excitation which is the sum of the excitations of many neurons, and that these central neurons obey the same laws and are excited under the same limitations as apply to the peripheral neurons which have been experimentally studied. To this article of faith the psychologist sometimes opposes another belief, that the organization of cerebral excitation corresponds to the organization of phenomenal experience. These two hypotheses are not necessarily consistent, and often we have to choose between them.

The two end-terms of the dependent series, the stimulus and consciousness, have been much more accessible to observation. The result is that the largest body of precise information within experimental psychology consists of correlations between these two terms. These correlations are the facts which make up the chapters on sensation and perception in any psychological handbook.

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[9] This difficulty is considered at length in Boring, "The Psychologist's Circle," *Psychol. Rev.*, vol. 38, pp. 177–182, 1931.

If the scientific mind could be satisfied with correlations, physiological psychology might have ignored the brain as inaccessible to its methods, and have remained content with correlations between stimulus and sensory process in the old days and between stimulus and response later on. The experimental method itself yields, in the first instance, mere correlations; nevertheless, the scientist demands something more. He wants insight into the relationships, a complete and immediate understanding which seems to leave no further questions to be asked. Many persons, in learning to extract square roots by the use of a calculating machine, discover for the first time the rule that the sum of a given number of consecutive odd numbers equals the square of the number of numbers summed; the sum of the first *three* odd numbers, 1, 3, 5, is 9, the square of *3*. Such a relation is a mere correlation and it seems, when first discovered, a great mystery. Even the proving of the general rule by algebra may seem to leave the mystery intact. If, however, one draws big geometrical squares made up of unit squares, one sees at once why to any square one must add a "next odd number" of squares in order to get the next larger square. The mystery has gone and we have what I am calling insight.

It is this need for insight that has forced the brain upon psychologists. The gross psychophysical correlation must be made more intimate. We want, in Fechner's phrase, an "inner psychophysics." Nevertheless, even if we had this knowledge of the brain and the resultant correlations, we should still be wanting insight in both parts of the picture. We should, on the one hand, want more intimate knowledge of the relation of stimulus to brain, and this sort of knowledge we are now actually beginning to get in the all-or-none law of neural excitation, in the frequency theory of intensity that Adrian has so ably promoted, and in the experiment of Wever and Bray on the nature of the impulses in the auditory nerve. Very slowly this physiological continuity is getting worked out. On the other hand, the correlation between consciousness and the events in the brain shows no signs of yielding to insight because there is no conceivable way in which insight can transcend the dualistic gap between mind and body. If there were any ground for dualism, if immediate experience as such seemed capable of scientific study, we might shrug our shoulders and decide to make the best of an unsatisfactory situation. Since, however, dualism seems both to fail to give us a satisfactory scientific dichotomy and also to exclude insight from psychophysiology, we ought, it seems to me, to make all haste to abandon it.

Let us now get down to business and see what there is to be said, for the purposes of psychology, about events in the brain. We had best accept, I think, four of Titchener's dimensions of consciousness[10] as setting the main topics for investigation. Consciousness is organized in respect of four dimensions: quality, intensity, extensity, and the temporal dimension which Titchener called "protensity." We may begin with intensity.

Twenty years ago the physiology of intensity offered little difficulty. A strong stimulus gives rise to an intense sensation; presumably the middle of this causal sequence must consist of strong excitation. However, this simple view became untenable with the acceptance of the all-or-none theory of excitation of the neuron. It seemed at first as if a multiple-fiber theory of intensity were the only remaining possibility, that degrees of sensory intensity must depend upon the number of fibers stimulated. Then came the frequency theory, the generalization, now well established, that a stronger stimulus may excite a greater frequency of impulses in a single fiber.[11] It is not necessarily true that the frequency theory of intensity must displace the multiple-fiber theory. Some of Hecht's conclusions point to the possibility that the stronger stimulus gives rise both to the excitation of a greater number of fibers and to a greater frequency of excitation in the fibers stimulated.[12] The volley theory of Wever and Bray is also such a view.[13]

When such theories are being discussed, it is natural to ask whether there must not be a summation of separate impulses in the brain. I believe that such a question generally indicates the existence of an implicit belief that introspection gives direct information about the brain, that, since sensory intensity is not anything like a frequency or a spatial dispersion, the brain ought somehow or other to collect the separate impulses in order to get some single unitary state that corresponds to what phenomenal intensity itself seems to be. The multiple fiber theory calls for the summation of the impulses in separate fibers; the frequency theory calls for the summation of successive impulses in the same fiber; and any combination of the two theories calls even more for summation, since, when different causes give the same effect, we want some insight into how the different causes are effectively the same.

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[10] E. B. Titchener never explicated his doctrine of conscious dimensions beyond his twelve-line note in *Amer. J. Psychol.*, vol. 35, p. 156, 1924.

[11] *Cf.* E. D. Adrian, "The Basis of Sensation," New York, 1928.

[12] See the summary of S. Hecht's views, H. Hoagland, "The Weber-Fechner Law and the All-or-none Theory," *J. General Psychol.*, vol. 3, pp. 354–359, 1930.

[13] E. G. Wever and C. W. Bray, "Present Possibilities for Auditory Theory," *Psychol. Rev.*, vol. 37, pp. 365–380, esp. 376–380, 1930.

Now I think we can indicate positively the sense in which summation must occur on any theory of intensity, but before I go into that matter I wish to point out how already prevalent is this view of the direct correspondence between consciousness and the brain.

Most psychologists have accepted this conception as a matter of course. It is the common assumption in different physiological theories of Weber's law, the theories of Wundt and G. E. Müller. Köhler is the most courageous modern to state the general view. He thinks of intensity as the electrical charge of a concentration of ions in the nervous tissues. He dislikes a constancy hypothesis between stimulation and central excitation, and so he suggests how the logarithmic relation of Weber's law might occur on the purely physiological level. However, Köhler likes a "constancy hypothesis" of the relation of consciousness to the brain (of course, he does not call his hypothesis by that term), so that there he supposes a simple relation between gradients of intensity and of electrical potential.[14] This notion of Köhler's, that there is a direct and simple correspondence between consciousness and events in the brain, only just misses what I take to be the necessary denial of dualism.

The physiologists are apt to avoid the problems of consciousness, but when they consider them they tend to make the same assumptions as the psychologists. Let me illustrate by reference to a recent article of Hoagland's on the Weber-Fechner law. This law requires that the plot of the measure of sensation against the logarithm of the stimulus should be linear. Hoagland, citing Hecht, points out that the Weber-Fechner law is known not to hold at the extremes, and that this semi-log plot may be, not linear, but sigmoid in shape, thus corresponding to other functions familiar to physiologists.[15] He cites certain cases where what we may call "excitation" does show this kind of dependence upon the logarithm of the stimulus. He cites Hecht's analysis of König's data for the visual discrimination of brightnesses as proving the same point. What can one conclude? That Hecht and Hoagland, at least, have rejected dualism and are ready to accept introspection as a measure of physiological excitation, for König's data were introspective, and they are ready to bring them under a physiological generalization.

Certainly then it is good form to assume that sensory intensity is a symbol of neural excitatory intensity. Can we justify the view further?

Here it is, I think, that we need to appeal to the physiology of introspection. Let us suppose that the occurrence of a given sensory intensity leads to a judgment of its degree. It does not matter whether that judgment is a word, spoken aloud or written on paper, in English or German, or whether it is the pressing of a key connected with an apparatus, or whether it is some imaginal form of note-taking which only later leads to expression. The judgment differentiates *the* intensity from other intensities, and as such it is a response to *the* intensity. In the absence of such response there can be no knowledge that the intensity occurred and hence no introspection.

However, the discriminative response is a response *to* the intensity, which one must now think of in physiological terms. Do the excitations of many fibers have to be summated in order that a response may occur to them? Do the successive excitations of a single fiber have to be summated to lead to a response that depends upon the frequency? Not necessarily in any objective sense, if summation implies that all the impulses are collected together into one place at one instant. On the other hand, there is summation in the sense that the response is to the totality of the impulses, that all the impulses are collectively effective in producing a single response which is characteristic of them all as a totality. For instance, if the neural impulse is electrical in nature, there need never be a summation of ion charges, but there must be a functional summation into a single physiological effect.

The experiment of Wever and Bray illustrates this point beautifully.[16] They hooked an electrode on the central end of the cat's auditory nerve where it enters the medulla; they talked to the cat and greatly amplified the currents of action in the nerve, leading the amplified currents to a loud speaker. Human speech was heard over the cat's nerve with little distortion and tonal frequencies up to 4000 cycles were accurately transmitted. It is still extremely doubtful whether a single auditory fiber can transmit a frequency greater than 1000 cycles. However, Wever and Bray transcend this difficulty in their "volley theory" which combines the multiple-fiber and the frequency theories of intensity. I can not expound this theory here, but the point of it is that, if a tonal frequency and amplitude, corresponding respectively to a given pitch and intensity, are put into the ear, the resultant excitation in the auditory nerve is utterly different, consisting of a number of frequencies in a number of fibers, and yet a simple electrode is able, out of the total effect of the excitations within the nerve, to pick up the original frequency and amplitude. The electrical circuit "responds" to the totality of events in the nerve, without the original frequency and amplitude ever being reinstated in the nervous tissues. In the same way the physiology of sensory intensity must be at least a simple totality of degree of excitation, even though it may not be summated at any point at any one instant of time.

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[14] *Cf.* Köhler, "Die physischen Gestalten in Ruhe und im stationären Zustand," Braunschweig, Germany, pp. 211–227, 1920.

[15] Hoagland, *op. cit.*, 351–370.

[16] Wever and Bray, "The Nature of Acoustic Response: the Relation between Sound Frequency and Frequency of Impulses in the Auditory Nerve," *J. Exper. Psychol.*, vol. 13, 373–387, 1930.

If we turn from the problem of intensity to the problem of extensity we find that ever so much more has been written about this problem and that the solution is less certain.

The oldest theory of extensity is the projection theory. It is a theory that was helped a hundred years ago by the theory of the specific energy of nerves, for, if the mind perceives, not objects, but "the states of the nerves" (as Johannes Müller said), it can "perceive" spatial pattern only if it be projected upon the brain. Now-a-days, Köhler, while denying projection, nevertheless keeps our thought in the same channels by his principle of correspondence between the spatial order of phenomenal experience and the underlying physiological processes.[17] It is certainly good form to suppose that the perception of shape and size is dependent upon spatial differentiation in the fields of central excitation.

There is not the same amount of supporting evidence for this view as there was in the parallel case of intensity. Nevertheless, I think that the conclusion for intensity helps us to a belief in a broad conception of correspondence for all the dimensions of consciousness. It looks as if some sort of physical intensity (like electrical potential) were the physiological fact of sensory intensity. It looks as if spatial differences of stimulation were the occasion of spatial differences of central excitation, and temporal differences of stimulation, of temporal differences in central excitation. We are not in such a statement making an appeal to analogy; we are saying that the physical dimensions of peripheral stimulation are likely to be the dimensions of the organization of central events, that there are not enough possible dimensions for us to expect a change of kind, and that the adequacy of perception to certain dimensions of the external world is thus readily explained.

The projection theory of extensity would thus be a very acceptable theory were it not inadequate to the facts. Since we can not undertake to review the entire field of space perception, let us select for consideration two special problems: the problem of the third dimension in vision and the problem of visual size.

Koffka has recently suggested that the existence of the third dimension in visual perception implies a tridimensional neural pattern in the brain.[18] Such a view is consistent with Köhler's theory of correspondence, but I think that a stronger case can be made out for it than a mere appeal to an uncertain generalization. So much has been said about the dependence of the perception of depth and distance on convergence, accommodation and retinal disparity, that Koffka is at pains to take the cases of depth that occur in simple drawings, where neither accommodation nor any binocular *differentia* is possible. He shows that you may see the Necker cube in either perspective, but that you practically can not see it as a flat geometrical design in the plane of the paper. What is the difference then between the plane design and the two perspectives? As projections they would be identical. If the two-dimensional pattern means a two-dimensional field of excitation, it is almost inevitable to look for a tridimensional field when the third dimension comes in immediately to the perception.

The case becomes stronger when we consider how retinal disparity works in stereoscopic vision. Let us think of the case of the truncated cone, which stretches out convexly toward the observer in stereoscopic vision. Each eye sees only a small circle within a large circle, but the relation of the small circle to the large circle is disparate for the two eyes. When the eyes first view the two drawings, there may appear two completely separate images in perception. Then the eyes move in respect of each other until there is seen, let us say, but a single large circle. At this stage the small circles may remain double within the single large circle. Thus far the experience fits the projection theory. The two large circles appear as two circles until the eyes move so that they lie upon corresponding points; then there is but one circle, because the two circles are projected upon the same locus in the brain. Moreover, we see that the eyes tend to move so as to bring similar images upon corresponding points. It is as if the mechanism of vision operated in the interests of simplification.

However, the eyes can never move so as to make both the large and the small circles coincide at the same time. If the small circles coincide, the large circles must be double, and *vice versa,* if we keep to projective geometry. However, projective geometry is just what perception does not preserve. Presently both small and large circles coincide and we see the truncated cone as a solid. Is not the conclusion almost inescapable that the tendencies for the large circles to combine and the small circles to combine are realized by the establishment of the circles in different fields, which for bidimensional figures would have to be separated in a third dimension?[19]

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[17] Köhler, "Gestalt Psychology," *op. cit.*, p. 64.

[18] Koffka, *loc. cit.*

[19] There is a very simple system of geometrical projection in which a disparity, which is like retinal disparity, actually gives the projection in the third dimension, but I forego its discussion since I can not make it seem like acceptable physiology.

Now let us turn to the problem of visual size. It seems probable that the perceived size of stimuli at the same distance from the observer is proportional to the size of the corresponding retinal images. As usual we can begin with a projection theory.

However, a projection theory breaks down when we consider size in relation to distance. As a stimulus-object is moved away from the observer its perceptual size decreases, but it decreases not nearly so fast as does the size of the retinal image. The alley experiments have worked out the law of the dependence of phenomenal size upon distance. The facts are as if perception compromised between the projection theory and some other theory, under which a given object would maintain its size, irrespective of distance.

There is another way in which size varies. The moon in the zenith is perceptually smaller than the moon on the horizon. For all the controversy that has gone on about this illusion, it seems fairly accurate to say that the size of the moon or of any other stimulus-object is diminished when the head and the eyes assume the strained position required for looking at the zenith and *when distance is indeterminate.* It is this second condition that has fooled the experimenters. The illusion fails, or is reduced to a few per cent., for an artificial moon a few feet from the observer. Schur showed that the illusion may be as much as 50 per cent. for cardboard moons 33 meters from the observer. Beyond 33 meters in the vertical it is not possible to carry most experiments, but the implication of Schur's results is that position of the head and eyes makes a difference to size when distance is indeterminate, as it becomes when it is great. With shorter and determinate distances, the laws of the alley experiments hold. With the moon, distance is completely indeterminate and the illusion is maximal.

It thus appears that perceptual size is a complex function of retinal size, of distance, and at times even of the position of the head and eyes. Moreover, there is some ground for belief that this variation in size applies to three-dimensional fields. It is very hard to adjust this sort of physiology to the conventional notions of neuron reflex arcs. These phenomena accord much better with Lashley's principles of equipotentiality and mass action in the cerebral cortex.[20] Hunter has criticized Lashley's views on the ground that it is possible to explain the animal behavior in question in terms of a more conventional physiology.[21] The difficulty with Hunter's position, so it seems to me, is that conventional physiology, even if it can explain Lashley's data, can do very little else for the theory of perception. What, for instance, can it do for these problems of the visual perception of solidity and of size?

I am not proposing that we disregard facts in favor of theories. I am proposing merely that we accept, tentatively, the most productive hypotheses, those with the greatest resolving power. We may need some day to abandon the hypothesis that consciousness always involves some kind of brain action. However, I think that this view should be kept just now, and with it the more explicit view that spatial and intensive phenomena, given in introspection and representing respectively spatial and intensive aspects of the stimulation, are symbols of spatially and intensively differentiated events within the brain. The evidence for such an hypothesis is scanty enough, goodness knows, but I think it is greater than the grounds for faith in the simple reflex-arc theory of the brain. If we must choose an hypothesis, let us choose one that gives us some insight into the extensive knowledge of perception which experimental psychology includes to-day.

There is no time for me to discuss the other two dimensions of consciousness. Of protensity, the temporal dimension, we know but little. We should be looking, with Köhler, for durations in the brain when introspection shows duration to be a characteristic of the perception.

Quality has had no acceptable physiological hypothesis for itself since the theory of the specific energy of nerves and the related theory of sensory centers broke down. All we can be sure of is this: whatever quality is within the brain, it must be differentially dependent upon whatever quality is within the stimulus. In tonal hearing this view means a frequency theory of quality, and Wever and Bray have shown how such a view is not necessarily incompatible with the theory of peripheral frequency for intensity. In the other senses we are dependent upon more knowledge of the receptor processes.[22]

Let me see if I can now, in closing, repeat all that I have said in the compass of a few words.

Dualism is dead. It ought to be buried. It can not work for us any more and we do not need it.

The great delusion of psychology has been the belief that we can have a science of direct experience. Scientific facts come out of experience, but they are then no longer in it. Science does not attempt to reconstitute experience; it builds up inferentially a world of constructs which are its realities.

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[20] The standard reference is K. Lashley, "Brain Mechanisms and Intelligence," Chicago, 1929; but perhaps the clearest exposition of this point is his "Mass Action in Cerebral Function," SCIENCE, vol. 73, pp. 245–254, 1931.

[21] *Cf.* W. S. Hunter, "A Consideration of Lashley's Theory of Equipotentiality of Cerebral Action," *J. General Psychol.*, vol. 3, pp. 455–467, 1930.

[22] Perhaps this view accords with J. P. Nafe's objections to the theory of the specific energy of nerves and thus with his quantity theory of feeling; *cf.* his discussion in "The Foundations of Experimental Psychology," pp. 395–399, Worcester, Mass., 1929. I have never understood Nafe's theory; but if he means that quality must ultimately be understood as a function of the quantifiable aspects of nerve-conduction and the relationships that are quantitatively statable between excitations, then I suppose that all scientifically minded psychologists would immediately agree with him.

A careful examination of the introspective process shows that introspection, like any other observation, is the taking note of symbols that mean occurrences in this constructural or real world.

We are, therefore, free to examine these symbols, the phenomenal data of introspection, to see what they can symbolize with the greatest profit for scientific psychology; and we conclude that neural events are the sort of mental constructs that introspective data most effectively "intend."

We can then set out to test this view, to see what it will yield us in the way of a physiological psychology. Such a view is necessarily subject to test and to correction, in the same way that a galvanometer is subject to test and correction as to how it means or "intends" the strength of an electric current.

When we go to the physiological theories of psychologists (and of some physiologists, too) we find many views consonant with the thought of the present paper, as indeed we could have known from the start, since the paper has been written to explicate and evaluate these views.

In general, the most plausible theory of the brain seems to be that the four conscious dimensions find reality there in four physical dimensions of intensity, extensity, duration, and an uncertain fourth which must have an immediate dependence upon the physical variable for quality in the stimulus.

Such a general view is most definitely explicable for intensity. Sensed intensity must represent degree of excitation in the brain. Such excitation does not, however, have to be localized at a single place at a single time, except that it must all be effective in producing a simple subsequent neural event, which is the first physiological term of the introspective process.

In respect of extensity, the notion that introspection tends approximately to mirror the brain is, at the present day, a plausible view and a useful one. A more conservative physiology not only leaves one without an hypothesis for most of the facts of space perception, but implies certain limitations which are contradicted by the facts.

Finally, in urging this view upon you for serious consideration, I would make bold to remind you that scientific hypotheses and scientific truth are temporary and provisional, and that hypotheses that are false to-day have been largely instrumental in leading us to what is true to-day. However, I doubt if a false hypothesis ever led far toward the truth unless it was at the time believed to be true. You have in that statement both my admonition and my apology.

SCIENTIFIC EVENTS

THE MASTER'S DEGREE FOR POSTGRADUATE STUDENTS IN THE MEDICAL SCHOOL OF COLUMBIA UNIVERSITY

ACTION to establish higher standards in the practice of surgery and other specialties of medicine has been taken by the Columbia University Council. Dean Willard C. Rappleye, of the Medical School, characterized the step as having "important significance of a public character." He said:

> The university has adopted a standard of training in each of the clinical specialties, successful completion of which will carry the degree of master of science. The university, however, will not grant recognition for postgraduate training for less than that which will qualify the man as competent in the specialty concerned.
>
> The time will come in this country, as it has in others, when the public and the profession will demand that only those who are properly trained to do major surgery, for example, will be permitted to do it. At the present time large numbers of doctors are doing surgery who are quite incompetent and untrained.

The new regulations for the degree of master of science in postgraduate medical education follow:

> The university grants recognition for acceptable postgraduate work in the clinical specialties by means of the degree of master of science.
>
> This degree is non-specific, that is, it does not carry a designation of the special field of study to which the student has devoted himself. Only a broad definition of requirements is stated in order to permit flexibility in the training for the various clinical specialties and adaptation of that training to the needs and preparation of each student. The specific requirements for each of the specialties are formulated by the departments concerned.
>
> A student who wishes to secure the degree of master of science in postgraduate medical work must present evidence of graduation from a medical school approved by Columbia University, and completion of an internship of not less than one year after graduation in a hospital approved by Columbia University.
>
> Students who offer work pursued in other universities, laboratories or hospitals for part fulfillment of the requirements for the degree of master of science as hereafter set forth, should file a certified statement of such training with the director of university admissions for evaluation.
>
> A student admitted to the university for postgraduate medical studies who wishes to become a candidate for the

degree of master of science will be registered upon recommendation of the department in which his work is to be done.

The requirements for the degree of master of science are:

A period of study after the internship of not less than three years in the university or in hospitals and laboratories recognized by it, at least one calendar year of which must be spent in this university.

Such intensive graduate training in the basic medical sciences of anatomy, embryology, physiology, biochemistry, pharmacology, pathology, bacteriology, and in other fields of science as shall be recommended by the departments concerned and approved by the Administrative Board on Postgraduate Studies in Medicine.

An active experience during the three-year period of not less than eighteen months in the hospital, clinics and diagnostic laboratories of the specialty elected.

Written, oral and practical examinations and a dissertation may be prescribed in the specialty elected and in clinical, laboratory and public health fields to which the specialty is related.

A student admitted to the university for postgraduate medical training may become a candidate for the degree of doctor of philosophy if he meets the requirements for that degree that are prescribed by the faculties of political science, philosophy and pure science.

FURTHER INVESTIGATION OF COSMIC RAYS

Plans for a concerted effort to discover the source and nature of cosmic rays, involving the measurement of these radiations at eighteen widely scattered sites on the earth's surface, are disclosed by Dr. Arthur H. Compton, professor of physics at the University of Chicago.

During the spring and summer of 1932 more than a dozen physicists, working in several parties under the direction of Dr. Compton, will test the intensity of the rays at thirteen sites. Electrometer readings, taken largely in mountain ranges, will be made in Panama, Peru, New Zealand, Australia, Hawaii, Alaska, the Argentine, Chile, Kashmir, Ceylon, Singapore, Java and South Africa. The Carnegie Foundation and the University of Chicago will share the expense of the study.

The present expeditions continue the work which Professor Compton and his collaborators carried on last September and October on Mount Evans, Colorado, and on the Jungfrau in the Swiss Alps. The projected measurements will be made at widely distributed stations and at different altitudes on mountains ranging in height from 7,000 feet to 26,000 feet.

The objective of the expeditions, according to Dr. Compton, is "more complete knowledge of the nature and place of origin of the cosmic rays. A survey such as this should give the most adequate test that has yet been devised to distinguish whether the cosmic rays are photons, such as light and x-rays are, or electrons, such as give rays to the earth's aurora. Because of the effect of the earth's magnetic field, electrons should give less intense rays near the equator than near the poles. Likewise, if the cosmic rays have their origin in the earth's atmosphere there should presumably be variations with the geographical location."

Dr. Compton, who for several years has been measuring the rays in Eckhart Hall on the campus of the University of Chicago, will himself do a considerable share of the proposed work. Accompanied by his wife and his 14-year old son, Arthur Alan, who assisted him in the work on Mt. Evans, Dr. Compton will leave for Panama in March, to make tests on Mt. Chico, fifty miles from the Canal. His next stop will be Peru, where he will work in cooperation with the Carnegie station at Huancayo, making measurements over as wide a range of altitudes as possible and especially at very high altitudes.

Mt. Cook in New Zealand will be the next objective of the party, and the fourth point of observation will be Mt. Kosciusko between Sydney and Melbourne in Australia. From there Dr. Compton will proceed to Hawaii to set up his apparatus on Mauna Kea in Hawaii, and will then go on to Alaska, where Mt. McKinley has been chosen as the experimental site. Late in the summer Dr. Compton will return to America to join Dr. J. C. Stearns, of Denver University, and Dr. R. D. Bennett, of the Massachusetts Institute of Technology, both of whom have cooperated with him in previous cosmic ray studies, and will have spent the summer of 1932 in making further measurements in Colorado.

Three other cooperating parties will report to Dr. Compton at the end of the summer. One will take measurements on the Volcano Lanin in Patagonia and at Punta Arenas in Chile. A second, in charge of Professor S. N. Naude, recently a research fellow at the University of Chicago and now on the faculty of the University of Cape Town, will climb Mt. Winterhoek in South Africa, and will probably measure also the cosmic rays at Mt. Brukkaros.

In India, Professor J. N. Benade, of Punjab University, Lahore, will go to Mt. Nunga Purbat in Kashmir, the third highest peak in the world, and will, if possible, make tests at several altitudes ranging as high as 20,000 feet or more. Professor Benade will then proceed to Kandy, Ceylon, Singapore, Straits Settlement and Mt. Tjerimai, Java, for further measurements.

Negotiations are also being made with several independent groups, which are planning expeditions to the north and south polar regions within the next two years for the inclusion of physicists in the parties, to make still further cosmic ray measurements.

PRESENTATION OF THE PERKIN MEDAL TO DR. BURGESS

THE Perkin Medal, bestowed annually on "the American chemist who has most distinguished himself by his services to applied chemistry," has been awarded for 1932 to Dr. Charles Frederick Burgess, president of C. F. Burgess Laboratories, Inc., for "a lifetime of accomplishment" in this field.

The medal will be presented at a joint meeting of the Society of Chemical Industry, the American Chemical Society, the Electrochemical Society, and the Société de Chimie Industrielle at 8:30 P. M. on January 8, at the Hotel New Yorker.

Dr. Burgess will speak on "Research 'for Pleasure or for Gold.'" Howard F. Weiss, of New York, will describe the achievement of the medalist, and Professor Marston T. Bogert, of Columbia University, will present the medal. Dr. Allen Rogers, of Pratt Institute, Brooklyn, chairman of the American Section of the Society of Chemical Industry, which awards the medal, will preside.

The work of Dr. Burgess in applied chemistry and electrochemistry, done chiefly at Madison, Wisconsin, embraces for the most part the fields of electrolysis, electrolytic iron and its alloys, the metallurgy of zinc, the corrosion of iron and other metals, and the development of the dry cell.

He devised a method and apparatus for sterilizing liquids with nascent chlorine which has been used in Madison hospitals to treat badly infected wounds and gangrene, and by explorers for sterilizing drinking water. This method bears some relation to the successful chlorine sterilization treatments later used during the war.

Dr. Burgess was born June 5, 1873, in Oshkosh, Wisconsin. In 1895 he was graduated in electrical engineering from the University of Wisconsin, where he served as instructor and assistant professor for five years following his graduation. There he established a course in applied electrochemistry, the first in the United States and later he established the chemical engineering course. In this academic atmosphere he demonstrated that scientific research was of the highest value to industry. In 1910 he established the C. F. Burgess Laboratories to demonstrate the marketability of chemical research.

Dr. Burgess's early work in applied electrochemistry became of industrial importance. He devised a simple electrochemical method for removing the surplus brazing metal from the brazed iron bicycle frame. He demonstrated the commercial utility of the electrolytic cleaner, universally adopted for cleaning metals preparatory to electroplating, and perfected the fused salt aluminum electrolytic rectifier, since manufactured extensively.

In 1904 Burgess and Hambuechen presented their paper on "Electrolytic Iron" which has been the basis for the commercial production of electrolytic iron both in the United States and France. Shortly afterward Dr. Burgess was given a grant of $10,000 by the Carnegie Institution to continue this work. This grant resulted in an extensive research on electrolytic iron and its alloys, several thousand of which were made and investigated.

The work of Dr. Burgess in corrosion has been of importance in its commercial aspects. He applied the principle of over-voltage to dry cell construction when the price of zinc mounted rapidly during the war. He substituted terne and tin plate for the zinc bottoms in dry cells at a considerable saving in cost.

He did a large amount of work on stray current electrolysis and made surveys in many cities in the United States. Dr. Burgess has done a considerable amount of work in improving hot galvanizing and electrogalvanizing. He was granted a patent in 1908 for separating articles in the electric furnace to prevent their fritting together in the intense heat of the reaction zone. This method is now used extensively in electric furnace practice.

Other achievements of Dr. Burgess are the electrochemical production of white lead and chrome yellow, electroplating on aluminum, and a method for soldering aluminum. He devised methods of roasting zinc ores and then concentrating magnetically. He succeeded in having gas put on a heating value basis in Wisconsin, the first state to adopt this standard. During the war, he was instrumental in devising on a large scale successful methods for producing and purifying silicon and titanium tetrachlorides. In the dry battery field he has made many contributions.

Dr. Burgess is also president of the Burgess Battery Company, the Burgess Building Company, the Burgess-Parr Company and the Burgess Dry Cells, Limited, of Winnipeg. The five companies of which he is the head are the outgrowth of his effort to carry chemical engineering research to industry. They employ more than 1,000 workers and turn out about $6,000,000 of products annually.

The Perkin Medal was founded in 1906 at the time of the Perkin semi-centennial celebration of the coal-tar discoveries, the first medal being awarded to Sir William H. Perkin himself.

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A FULL account of the New Orleans meeting of the American Association for the Advancement of Science and the scientific societies associated with it, edited by the permanent secretary, will be published in the issue of SCIENCE for February 5. Officers of the association were elected on December 31 as follows:

PRESIDENT

Dr. John J. Abel, professor of pharmacology, the Johns Hopkins University.

VICE-PRESIDENTS

A—*Mathematics.* Professor Howard H. Mitchell, University of Pennsylvania.

B—*Physics.* Professor David L. Webster, Stanford University.

C—*Chemistry.* Professor Frank C. Whitmore, Pennsylvania State College.

D—*Astronomy.* Dr. Paul W. Merrill, Mount Wilson Observatory.

E—*Geology and Geography.* Professor Wm. H. Hobbs, University of Michigan.

F—*Zoological Sciences.* Professor Charles Zeleny, University of Illinois.

G—*Botanical Sciences.* Dr. H. L. Shantz, University of Arizona.

H—*Anthropology and Archeology.* Professor C. H. Danforth, Stanford University.

I—*Psychology.* Dr. Walter S. Hunter, Clark University.

K—*Social and Economic Sciences.* Professor William F. Ogburn, University of Chicago.

L—*Historical and Philological Sciences.* Dr. Waldo G. Leland, permanent secretary and executive director of the American Council of Learned Societies.

M—*Engineering.* Professor Dugald C. Jackson, Massachusetts Institute of Technology.

N—*Medical Sciences.* Professor Wm. H. Park, University and Bellevue Hospital College Bureau of Laboratories; director of the New York City Health Department.

O—*Agriculture.* Professor J. H. Gourley, Ohio Experiment Station, Wooster.

Q—*Education.* Dr. S. A. Courtis, University of Michigan.

ELECTED MEMBERS OF THE COUNCIL

Professor Arthur H. Compton, University of Chicago.

Mr. Austin H. Clark, Smithsonian Institution.

EXECUTIVE COMMITTEE MEMBERS

Professor D. R. Curtiss, Northwestern University.

Professor Joel H. Hildebrand, University of California.

GRANTS COMMITTEE

Dr. Philip Fox, director of the Adler Planetarium and Astronomical Museum, Chicago.

Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research, Yonkers, New York.

MEMBER OF THE FINANCE COMMITTEE

Dr. Arthur L. Day, director of the Geophysical Laboratory, Carnegie Institution, Washington.

REPRESENTATIVE ON BOARD OF TRUSTEES SCIENCE SERVICE

Professor Raymond Pearl, School of Hygiene and Public Health, the Johns Hopkins University.

SECRETARY OF SECTION C—CHEMISTRY

Dr. Reynold C. Fuson, University of Illinois.

SECRETARY OF SECTION H—ANTHROPOLOGY

Professor Carl E. Guthe, director of the Museum of Anthropology, University of Michigan.

SCIENTIFIC NOTES AND NEWS

THE thousand dollar prize given each year by the American Association for the Advancement of Science "for a notable contribution to science" was awarded at New Orleans to Dr. Carl Caskey Speidel, of the University of Virginia Medical School, for his paper concerned with the growth of nerve cells.

THE Astronomical Society of the Pacific has awarded its Catherine Wolfe Bruce Gold Medal "for distinguished services to astronomy" for the year 1932 to Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, British Columbia, who was recently elected Savilian professor of astronomy at the University of Oxford to succeed the late Professor H. H. Turner.

FRIENDS of Professor Chandler presented to the Trustees of Columbia University in 1910 a sum of money which constitutes the Charles Frederick Chandler Foundation. The income is used to provide a lecture by an eminent chemist and a medal for him. The lecturer this winter will be Professor James Bryant Conant, chairman of the division of chemistry, Harvard University. His research has included work on free radicals, hemoglobin, reduction and oxidation of organic compounds and quantitative studies of organic reactions. The lecture, entitled "Equilibria and Rates of Some Organic Reactions," will be given in Havemeyer Hall, Columbia University, on February 5, at 8:15 P. M.

DR. LOUIS B. WILSON, professor of pathology at the University of Minnesota and director of the Mayo Institute, was elected president of the Society of Sigma Xi at the New Orleans meeting, succeeding Dr. G. W. Stewart, head of the department of physics at the State University of Iowa.

AT the Andover meeting of the American Anthropological Association Dr. John R. Swanton, of the

Bureau of American Ethnology, was elected president for the meeting to be held next year at Atlantic City.

PROFESSOR REGINALD A. DALY, of Harvard University, was elected president of the Geological Society of America at the recent meeting at Tulsa, Oklahoma. He succeeds Professor Alfred C. Lane, of Tufts College. The following vice-presidents were chosen: Professor Nevin M. Fenneman, University of Cincinnati; Dr. W. E. Wrather, of Dallas, Texas; Dr. R. S. Bassler, U. S. National Museum, and Professor A. N. Winchell, University of Wisconsin. Other officers are: *Secretary,* Dr. Charles P. Berkey, Columbia University; *Treasurer,* Dr. Edward B. Mathews, the Johns Hopkins University, and *Editor,* Mr. Joseph Stanley-Brown, of New York City. New councilors are Dr. George W. Stose, U. S. Geological Survey, and Dr. Frank R. Van Horn, Case School of Applied Science.

DR. L. V. REDMAN, who has served as president-elect of the American Chemical Society during 1931, becomes president with the new year. By vote of the council the following have been elected to the offices indicated for the terms beginning January 1, 1932: *President-elect,* Professor A. B. Lamb, of Harvard University, editor of the *Journal of the American Chemical Society;* director for the second district, comprising the States of New York and New Jersey, E. M. Billings, Eastman Kodak Company, Rochester, New York; director for the fifth district, comprising the States of Illinois, Indiana, Michigan and Wisconsin, Professor Roger Adams, University of Illinois; director-at-large, R. E. Wilson, director in charge of the Development and Patent Department, Standard Oil Company of Indiana; councilors-at-large, Dr. G. J. Esselen, Jr., Boston; Professor Ross Aiken Gortner, University of Minnesota; Dr. E. Emmet Reid, the Johns Hopkins University, and Dr. E. R. Weidlein, director of Mellon Institute of Industrial Research.

DR. EDWIN B. FRED, professor of bacteriology at the University of Wisconsin, vice-president of the Society of American Bacteriologists, was elected president of the society at the recent Baltimore meeting. He succeeds Dr. J. Edward Brown, associate professor of bacteriology at the Johns Hopkins University School of Medicine. Dr. William Mansfield Clark, DeLamar professor of physiological chemistry at the Johns Hopkins School of Medicine, was elected vice-president to succeed Dr. Fred. Dr. J. M. Sherman, of Cornell University, was reelected secretary-treasurer. Dr. Ivan C. Hall, of the University of Colorado, and Dr. Ralph R. Mellon, of the Institute of Pathology of the Western Pennsylvania Hospital, Pittsburgh, were elected members of the council.

DR. CHEVALIER JACKSON, of Philadelphia, was honored at the meeting of the Chicago Laryngological and Otological Society, Chicago Medical Society, Chicago Tuberculosis Society and the Chicago Tuberculosis Institute on January 4. An appreciation of the work of Dr. Jackson in diseases of the lungs was given by Dr. Ethan Allen Gray; in peroral endoscopy by Dr. Joseph C. Beck; in medical literature with the brush and pen by Dr. Morris Fishbein; as a fellow of the American Medical Association by Dr. Edward H. Cary, Dallas, Texas, and as a doctor of medicine by Dr. Frank Billings. Dr. Jackson addressed the meeting on "Suppurative Disease of the Lung Following Operations Involving the Upper Air Passages."

THE *Journal* of the American Medical Association writes editorially: "On January 2, the date of this issue of the *Journal,* Dr. George H. Simmons, editor and general manager emeritus of the American Medical Association, reaches his eightieth birthday. The felicitations of organized medicine are tendered to him on this occasion. From 1898 until 1924 he served the American Medical Association as a leader who brought it from a small body with practically no assets and an insignificant publication to a great organization, financially sound, with the greatest medical journal in the world, and with numerous bureaus, departments and councils that have exercised magnificent leadership in their special fields. In 1924 he retired and has spent his time since that date in travel and in recreation during the summer in Chicago and in the winter at his residence in Hollywood-by-the-Sea, Florida. The record of his achievements is written daily in the work of the organization that he so wisely builded."

DR. CHARLES NICOLLE, director of the Institut Pasteur of Tunis, has been nominated commander of the French Legion of Honor.

THE title of emeritus professor in the University of London has been conferred on the following: Dr. E. J. Garwood, on retirement from the Yates-Goldsmid chair of geology at University College; Dr. C. Spearman, on retirement from the chair of psychology at University College, and Mr. W. E. Dalby, on retirement from the chair of civil and mechanical engineering at the Imperial College—City and Guilds College.

AT the Mount Wilson Observatory, Dr. Joel Stebbins, director of the Washburn Observatory, University of Wisconsin, has been appointed research associate for collaboration in stellar photometric studies, and Dr. W. H. W. Baade, of the Hamburg Observatory, has been appointed astronomer.

MR. LEON CAMPBELL, who for many years has unofficially directed the scientific work of the American Association of Variable Star Observers at Harvard

Observatory, has been appointed the first Pickering Memorial astronomer. With increased facilities, he will have entire supervision of the observational work of the association, with headquarters at the Harvard Observatory. The "Pickering Memorial Fund" has been raised through the joint efforts of the American Association of Variable Star Observers and the Harvard Observatory to memorialize the work of Professor Edward C. Pickering. The income is to be used almost wholly to promote the study of variable stars.

PROFESSOR R. B. BRODE, of the department of physics of the University of California, will lecture at the Massachusetts Institute of Technology from February 6 to June 6.

A NEW pathological institute has recently been opened at the Sen Yatsen University in China, under the direction of Dr. Ernst Dormanns.

MR. JAMES A. BERRY, formerly of the department of bacteriology of the University of Washington, has been placed in charge of the microbiological studies on frozen-pack fruits and vegetables in the frozen-pack laboratory of the Bureau of Plant Industry at Seattle, Washington. This laboratory was established recently for the purpose of carrying on research and experimental work in all phases of preserving horticultural products by freezing.

DR. DAVENPORT HOOKER, of the University of Pittsburgh, was recently elected a member of the editorial board of *The Journal of Comparative Neurology.*

DR. F. HASTINGS SMYTH, who holds the doctorate of the Massachusetts Institute of Technology and was formerly a member of the scientific staff of the Geophysical Laboratory of the Carnegie Institution of Washington, was ordained a deacon in the Anglican Church on December 20. He will be attached to the staff of the Church of St. Martin, Brighton, England.

ACCORDING to *Nature*, Dr. H. R. Lang, acting secretary of the British Institute of Physics, has been appointed secretary of the institute and editor of the *Journal of Scientific Instruments*. Dr. Lang carried out research with the late Professor H. L. Callendar, and was afterwards demonstrator in physics at the Imperial College of Science and research fellow of the Institution of Petroleum Technologists.

DR. F. S. SINNATT has been appointed director of fuel research under the British Department of Scientific and Industrial Research. He has been assistant director since 1924. Previously he was lecturer on fuels in the University of Manchester faculty of technology, and director of research to the Lancashire and Cheshire Coal Research Association.

DR. ALBERT EINSTEIN arrived in California on December 29.

DR. KIRTLEY F. MATHER, professor of geology at Harvard University, has leave of absence for the second half of the year 1931–32.

Industrial and Engineering Chemistry reports that the Division of Chemistry and Chemical Technology of the National Research Council has recommended the following as delegates to the Madrid meeting of the International Union of Chemistry, April 3 to 10, 1932: *Members of the Council of the Union:* John Johnston, Charles L. Reese, Frank C. Whitmore, W. D. Bancroft (alternate for Claude S. Hudson), Edward Bartow (alternate for Charles L. Parsons), and H. E. Howe (alternate for James B. Conant). *Delegates:* Perry A. Bond, Hippolyte Gruener, J. R. M. Klotz, Henry G. Knight, Herbert R. Moody, Merle Randall, R. R. Sayers, Alexander Silverman and E. W. Washburn. The International Union of Chemistry will meet at the same time as the ninth International Congress of Pure and Applied Chemistry.

THE African expedition led by Professor and Mrs. Cockerell, and including Miss Alice Mackie and Mr. and Mrs. John Ogilvie, entered Africa at Lobito Bay in July and visited various places before reaching the Cape Province. The collections of insects are extensive and some mollusca were obtained. Miss Mackie took moving pictures and other photographs. Mr. and Mrs. Cockerell sailed from Cape Town at the end of November, leaving the others to continue the work in South Africa, probably for several months.

THE Field Museum of Natural History is sharing in a zoological expedition to French Indo-China, led by M. Jean Delacour, the French zoologist. The participation of the museum is financed by Mr. Marshall Field, of New York. The Paris Museum of Natural History and the British Museum (Natural History) will receive part of the collections. The expedition will return in May, 1932, after visiting little known regions in the province of Laos from Vientiane to Muong-Ting.

MR. LUCIUS S. STORRS, president of the United Railways and Electric Company of Baltimore, gave the second Aldred Lecture of the year at the Massachusetts Institute of Technology on January 8. He spoke on his "Engineering Experiences."

THE lectureship in science established several years ago by the Wisconsin Alumni Research Foundation of the University of Wisconsin was filled this year by Dr. Robert A. Millikan, of the California Institute of Technology. Dr. Millikan visited the university on January 5, 6 and 7. While there he conferred with faculty, graduate students and research workers in several departments, and gave several talks on research work. The title of his lecture on January 5 was "The March of Science." This is the third lecture given under the auspices of the foundation, the other two lecturers being Dr. Walter B. Cannon, of the Harvard Medical School, and Dr. Ross Aiken Gortner, of the University of Minnesota.

Professor Henry E. Sigerist, director of the Institute of the History of Medicine in the University of Leipzig, gave a lecture at the University of Wisconsin on December 10 on "The Medicine of the Renaissance"; before the Chapter of Alpha Omega Alpha, of the University of Minnesota, on December 11 on "The Medicine of the Renaissance"; in the Mayo Foundation on December 14 and 15 on "The Development of Medicine during the Nineteenth Century," and "The Evolution of Medical Ethics"; before the Des Moines Academy of Medicine on December 16 on "The Medicine of the Renaissance: Fracastoro, Paracelsus, Veslaius, Pare," and at the University of Nebraska on December 17 on "The Medical Literature of the Early Middle Ages." Professor Sigerist attended the meeting of the American Historical Society in Minneapolis during the holidays and then went to San Francisco, where he will lecture on January 10. The arrangement of his itinerary in the Middle West was made by the Mayo Foundation.

The executive committee of the second International Congress of Tropical Medicine announces that the congress, which was to be held in Amsterdam from September 12 to 17, has been postponed. Owing to economic conditions, the Dutch Government feels unable at present to grant its financial support, and private contributions so far received have been inadequate to cover the estimated expenses of the meeting. Subscription fees which have already been paid will be returned.

Professor E. G. Conklin, of the department of zoology of Princeton University, was reelected president of the board of trustees of the Bermuda Biological Station for Research, Incorporated, at the annual corporation meeting held in New York City on December 28. The other officers who were also reelected are Professor H. W. Rand, Harvard University, *secretary*, and Professor R. G. Harrison, Yale University, *treasurer*. Six members of the board of trustees were elected to serve until 1935. They are: Dr. E. J. Allen, director of the laboratory of the Marine Biological Association of Plymouth, England; Dr. E. V. Cowdry, Washington University, St. Louis; Professor E. Newton Harvey, Princeton University; Professor J. F. Fulton, Jr., Yale Medical School, and Dr. Wheeler and Professor Rand. Dr. J. F. G. Wheeler, of London, was appointed director of the station, which will be formally opened on January 6. A group of members of the society sailed on December 29 to be present at the opening at which the governor of Bermuda, Lieutenant General Sir Thomas Astley-Cubitt, will preside.

The late Charles H. Tyler, who died on December 4, provided in his will for a bequest of $1,000,000 to establish and maintain a laboratory for surgical research at the Boston City Hospital. The laboratory is to be named for Dr. George G. Sears, professor of clinical medicine, *emeritus*, at the Harvard Medical School, who is a trustee of the hospital.

A research committee of the Indiana University School of Medicine has been appointed, consisting of Mr. Hugh McK. Landon, of the Fletcher Savings and Trust Co.; Mr. Peter C. Riley, president of the Republic Creosoting Co., which has one of the best equipped research laboratories of the Middle West, and Mr. Eli Lilly, of Eli Lilly and Company, leaders in pharmaceutical research; Acting Dean W. D. Gatch, Dean Burton D. Myers and Professor R. E. Lyons, of the department of chemistry. The committee will control the income from $200,000 set aside by the will of Mrs. Hugh McK. Landon, the income from the Louis C. Huesmann memorial of about $65,000, and important annual gifts from Eli Lilly and Company. Grants will be made from these funds for promotion of well-defined research projects, a written statement of which must be presented to the committee.

By the will of the late Mr. A. G. Weeks, of Marion, Massachusetts, his immense collection of butterflies of the world is given to the Museum of Comparative Zoology at Harvard University. With this is also bequeathed his entomological library and the sum of $100,000. This collection, long known as the finest butterfly collection in this country, was begun by Mr. Weeks when a young man by the purchase of the butterflies of Otto Poling. Later Mr. Weeks employed collectors to gather butterflies in South America, and published two volumes, beautifully illustrated, describing the new species, "Illustrations of Diurnal Lepidoptera Unknown to Science." In recent years he has added a large amount of valuable material both from collectors and from dealers. The collection is contained in forty-five fine cabinets.

The general and local collections of herbarium specimens of the New York Botanical Garden have been enriched by gifts of herbarium specimens presented by Dr. Charles E. Moldenke, of Plainfield, New Jersey, and his son, Harold Moldenke, the latter a registered student at the garden. Mr. Kenneth K. Mackenzie, a member of the board of managers, has presented his private herbarium. It contains approximately 40,000 specimens, largely from North America, but representing also various other regions. This is the largest single accession received by the garden in recent years. It is supplementary to Mr.

Mackenzie's previous gift of his local material and undistributed duplicates. Mr. Raymond V. V. Miller, brother of the late Waldron DeWitt Miller, associate curator of birds at the American Museum of Natural History, has contributed the latter's private herbarium, consisting largely of plants collected in New Jersey. The collection contains between 2,500 and 3,000 specimens and forms an important accession to the local herbarium consisting of plants growing within 100 miles of the City of New York.

SCIENCE SERVICE reports that the Seventy-Second Congress now in session is expected to take favorable action on a bill establishing a national park in the Florida Everglades. The last congress considered such a bill, the Park Service of the Interior Department made a favorable report on the project and the bill passed the Senate, but failed in the House because it got caught in a legislative jam. This park would be part of a "comprehensive eastern park system" as viewed by the National Park Service. Great Smoky Mountains Park and the Mammoth Cave Park project, as well as the Shenandoah region of Virginia are among the others. The National Park Service is continually asked to investigate park projects, and has now on its docket for such investigation fifty-five national park and forty-four monument projects. Accomplishments of the past year listed by the National Park Service include the development of museums in parks and monuments, particularly the unique plan to emboss an actual fossilized skeleton of a dinosaur in his own home territory in the Dinosaur National Monument. The park and monument system increased its total area from 10,339,506 acres to 12,113,621 acres.

MR. STEPHEN C. SIMMS, director of the Field Museum of Natural History, reports that more than one and one-half million persons visited the museum during 1931. This marks a new record for a year's attendance, and makes the fifth consecutive year in which the one million figure has been exceeded. The previous record was made in 1930 when the attendance was 1,332,799, over which the 1931 total represents an increase of 182,664 or approximately 13½ per cent. In addition to the number of persons actually coming to the museum, as recorded in the attendance figures, more than 700,000 children have been reached through the extra-mural activities of the museum conducted through the N. W. Harris Public School Extension and the James Nelson and Anna Louise Raymond Foundation for Public School and Children's Lectures. This brings the total number directly reached by the museum's activities to well over two million. Beyond these, a still wider but numerically incalculable public is reached by the publications issued by the museum and circulated internationally, and by press reports, motion picture newsreels and radio lectures concerning the institution and its activities. Mr. Simms writes: "It is most gratifying to observe the constant and rapid increase in attendance at the museum, because it reflects the growth of public interest not only in the institution but in the sciences which the museum's exhibits serve to illustrate. It indicates that the museum is successfully fulfilling its mission as an educational factor in the life of our city."

A SCIENTIFIC reunion was held recently at the British Museum (Natural History), South Kensington, by the director and scientific staff, who displayed a number of exhibits selected from recent acquisitions. The London *Times* reports that a large sketch map of Central America and the adjacent island groups, prepared by Mr. P. R. Lowe, created much attention, since it was decorated with the bodies of different species of the West Indian Flower-pecker (*Coereba*) according to their distribution. Copies of photographs of the Eastern Gorilla, presented by the proprietors of the *Times*, and the photograph by Lady Broughton of a Tanganyika lion were among the exhibits of the Zoological Department. Another zoological exhibit was an unusual trout, from the River Coa in Portugal, which habitually grows upon its head a filamentous mass of sedge. The department of botany showed specimens from the Argentine-Chilean border lent by the King, while the department of minerals displayed photographs and specimens from the meteoric craters at Henbury, Central Australia, which were made known this year as the second largest meteoric craters in the world. A meteoric stone found by Mr. Bertram Thomas was also on view.

DISCUSSION

A THEORY OF DISINFECTION

DUCLAUX, in his "Traité de Microbiologie,"[1] (1898) devotes a volume or more to a consideration of enzymes. The bacterial cell, according to his views, carries on its activities entirely through its enzymes, the cell itself being relatively inert. In the final analysis, the properties of the cells are those of its enzymes, and by defining the latter we have a complete description of the former.

While such a point of view could hardly be accepted in its entirety to-day, it still provides a very satisfactory basis on which to explain the various phenomena connected with the disinfection process.

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[1] E. Duclaux, *Traité de Microbiologie*, Masson et Cie, Paris, 1898.

Thus the apparent truth of Duclaux's proposition is revealed by such points as the following:

(1) Both enzymes and bacteria are destroyed by the same agents, *e.g.*, heat, light and chemicals. The effect of heat in each case becomes apparent at about 50 degrees Centigrade. Enzymes vary considerably in their response to chemicals, and no substance is known which is bactericidal and yet without action on any enzymes. Such agents as toluene are very destructive for certain bacterial enzymes. Mercuric chloride destroys the activity of enzymes but, on addition of a sulphide, the activity may be restored. Likewise bacteria "killed" by mercury may be restored to life by a similar treatment.

(2) In a dry condition, both enzymes and bacteria are highly resistant to heat.

(3) Both are resistant to cold to an astonishing degree.

(4) The rate of destruction when each is acted upon by an adverse agent follows that of a monomolecular reaction.

It will be seen that the phenomenon of disinfection may be explained on a no more complicated assumption than that the disinfecting agents act upon the enzymes of the bacterial cell in exactly the same way as if they were dispersed in solution. The cell itself need play no part; it is dead or alive at the end of a given exposure depending on whether or not it still contains a sufficient number of intact molecules of necessary enzymes. If a given species of organism contained in its make-up several different kinds of enzymes, one of which was very susceptible to the disinfecting agent, it would be this one which would determine the cell resistance.

It will be at once obvious from what we have said, that at the end of any given exposure three types of cells might be found in a suspension, *viz.*, cells which have not lost any enzyme, cells which have lost some, and cells entirely bereft of intact enzyme molecules. The last, of course, could not grow and would therefore be dead. One would expect a difference in the first two groups. In actual experimental work two types of survivors are found and while it is impossible to know the state of their enzyme molecules, their behavior accords very well with what one would expect from the enzyme theory. The two types actually found are:

(1) Organisms which appear not to have been affected by the disinfecting agent. They grow as well and as quickly as the untreated organisms.

(2) Organisms which develop only after a "lag,"[3] or, if tested on different media, are found to have become more particular in their nutritive requirements because of their exposure. The length of the lag period depends on the intensity and the duration of the treatment.

The types of survivors are well illustrated by some experiments of ours on an acid-fast organism.[3] This organism grew well on all solid media irrespective of the composition or the pH. It produced a large amount of alkali, bringing the medium on which it grew to pH 7.8. Practically the maximum number of colonies developed within 24 hours. After heating for one minute at 60° C. and plating, a few colonies developed within 24 hours, but the majority required 48 hours for development. When heated for 5 minutes no colonies appeared in 24 hours, a few appeared in 48 hours and many more in 72 hours. Finally, on heating for 20 minutes, no growth appeared in 72 hours and one colony developed in 96 hours. These tests were carried out with a medium of pH 6.6. It was found that a greater number of survivors could be obtained if the heated suspension were plated out on media of a pH close to the final one assumed by an unheated culture. Although the number of survivors was increased by such a medium the lag period was not affected. It will be seen that, provided the time of heating was short enough, a few organisms appeared to escape intact. Others were progressively injured as indicated by the lag before development or by their inability to grow on an acid medium.

In terms of the theory, our experiments would be explained as follows: A number, perhaps all, of the various enzymes in the make-up of the acid-fast organism were thermolabile at the temperature used. The application of heat progressively destroyed the enzymes so that at the end of a period of between one and five minutes no cells remained which had all of their enzyme intact. Some at this time still had enough enzyme to supply food so that more molecules of their kind could be formed, thus restoring the cell to its original condition. From 24 to 48 hours were required for this restoration. Other cells, which were more damaged, required longer periods. One type of enzyme molecule which was destroyed supplied alkali. This apparently was a more labile type of enzyme so that after certain heating periods there were cells totally lacking in this particular enzyme, yet having a sufficiency of all other necessary types. Such organisms recovered in an alkaline medium where the services of the enzyme in question were not so necessary.

The question may next be raised as to the resistance of two suspensions differing only in the average enzyme content of their cells. From the enzyme theory it would be evident that those cells having the greater numbers of enzyme molecules would be the more resistant. While such a case is difficult if not impossible to find with certainty, in practice, we probably have an approach to it in cultures of a given organism at different ages. In an older culture competition for nutrition is keener and one might expect therefore the greatest enzyme content per cell. Experimental results indicate that old cells are in fact more resistant than young ones. In the case of spores the situation is different. The freshly formed spore contains its maximum supply of enzyme. Being in a resting condition it can generate no more, so that the effect of time would result only in a decrease of that already present. Experiments carried out by several workers indicate that old spores are less resistant than young ones.

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[3] M. L. Isaacs, "Factors with Influence Tests of Bacterial Survival, I and II," *Jour. Bacteriology*, Vol. XX, No. 3, Sept., 1930.

There are other facts, besides those which we have considered, which may be explained in terms of the theory. Thus, the germicidal action of substances which lower surface tension may be pictured as due to a washing off of enzyme from the bacterial cell. Such also may be the effect of physiological saline solution. The problem of salt solutions is a complicated one, however. Differences in susceptibility depend on the kind of organism and the concentration and kind of surrounding ion.

It is a curious fact that Duclaux, although regarding enzymes as the basis of cell life, explained disinfection on a different theory. He assumed that in the case of heat, at least, a coagulation of the proteins of the bacterial cell was responsible for death. He based his theory on the observations of Marshal Ward on the *Bacillus rhamosus*. Ward had noted an apparent coagulation in the body of this organism when it was exposed to concentrated sunlight. A similar explanation of disinfection has been developed by Chick (1910) and more recently by Bancroft and Richter. Such a theory and the enzyme theory are by no means mutually exclusive, for most enzymes are either protein themselves or so closely associated with protein that they coagulate in the presence of those agents which react with proteins. The two theories differ chiefly in that one pictures the protoplasm of the organism as resistant, the other as labile.

The coagulation of the bacterial cell proteins affords in itself an adequate explanation of many of the facts observed in connection with disinfection. There are several phenomena, however, which are more easily accounted for by the theory of enzyme susceptibility. Some of these may be briefly mentioned. (1) Certain salt solutions such as physiological saline are immediately injurious or germicidal for some organisms under conditions which probably do not involve coagulation. (2) The results obtained with the acid-fast organism described above can hardly be explained on the basis of coagulation. (3) The greater resistance of young spores is difficult of interpretation in terms of coagulability. One would expect, if anything, a greater resistance in old spores.

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THE COTTON ROOT ROT FUNGUS INDIGENOUS IN ARIZONA DESERTS

Investigators who have been studying the cotton root-rot disease in Texas and Arizona have considered for several years that the fungus (*Phymatotrichum omnivorum*) was indigenous in the areas where the disease is prevalent. The occurrence of the fungus on the roots of certain native plants in the vicinity of cultivated areas, and the immediate appearance of the disease on susceptible crops, when planted on virgin lands, has been reported by Peltier, King and Sampson, Taubenhaus, Dana and Wolff, and by King and Loomis. At the root-rot conference at College Station, Texas, in January, 1931, Wolff reported the finding of infected wild plants and sclerotia on a railroad right of way that had not been under cultivation for forty or fifty years.

The writers have been studying the disease at Sacaton, Arizona, and have made it a practice on field trips through the desert to look for indications of the fungus on the native plants. Large areas of desert land are being brought into cultivation under several new irrigation projects in Arizona and California, so that it would be desirable to detect the presence of the disease before the expensive procedures of clearing, leveling and planting are undertaken.

On August 11, 1931, two of the writers observed extensive patches of spore mats of the root-rot fungus along the roadside in a desert area twelve miles north of Florence, Arizona, on U. S. Highway No. 80. These occurred intermittently over a distance of two miles on the vertical bank of the drainage channel made by the road grader in elevating the road bed. All the mats were located on the east side of the road, which was more shaded than the west, and which was still moist on the surface from recent rains. A profuse desert vegetation existed in this area consisting largely of *Covillea tridentata, Prosopis velutina, Franseria deltoidea, Opuntia fulgida, Condalia lycioides canescens, Sphaeralcea ambigua, Chamaesyce albomarginata, Aplopappus heterophyllus*, and various quick-maturing annuals. The nearest cultivated fields were about twelve miles distant, and the area, which was a high level plain near the mountains, was far separated from any of the general drainage water channels of the region.

On returning to the root-rot area three days later, spore mats were found not only along the highway, but in several places on the shaded banks of a small wash for a distance of a fourth mile from the road. Other spore mats were found beneath the shade of mesquite and Condalia trees and Franseria plants. Several native plants were excavated, and on the roots of some of them were found typical strands of the Phymatotrichum fungus. The roots of three species, *Chamaeesyce albomarginata*, *Aplopappus heterophyllus* and *Sphaeralcea ambigua*, showed evidence of definite injury by the fungus, but no lesions or rotted tissues were observed on the roots of *Prosopis velutina*, *Condalia lycioides canescens* and *Opuntia arbuscula*, on which the mycelium also occurred.

Samples of soil about one-half cubic foot in quantity were obtained from three areas near the patches of spore mats. These were washed in a set of sieves, and the coarser materials left on the sieves were examined for the presence of root-rot sclerotia. In one of the samples obtained from the roadside two sclerotia were found. When tested for viability in the laboratory one of them germinated.

This observation seems to afford definite evidence that the fungus is indigenous in virgin lands in the Southwest, and explains the occasional occurrence of the disease in the first cultivated crops that are planted after clearing the native vegetation.

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IS EVOLUTION ONLY A DETAIL IN THE DYNAMICS OF POPULATIONS?[1]

IN reading a recent copy of SCIENCE (June 26, 1931) I was much interested in certain rather naïvely dogmatic statements anent population growth, embodied in a paper by Professor W. H. Longley, entitled, "Evolution a Detail in the Dynamics of Populations."

It seems to me, without wishing on my own part to be too dogmatic, that certain of the statements in this article can be shown to be incorrect.

For example, the paper states that "the struggle for existence proceeds with an order as definitely predictable in its outcome as that manifested in a gaseous system under the terms of kinetic theory." It is my contention that such is the case if, and only if, the individuals of all the species concerned act as independent entities in the matter of decisions involving subsequent actions, in which case the unpredictable actions of individuals can be treated in terms of statistical "mean actions." If, on the other hand, any considerable group of individuals, whether all of one species or not, are sufficiently advanced mentally to "put their heads together" and make a group decision, the nature of this decision will not be *à priori* determinable, hence, if it has any effect on the population growth, the rate and nature of that growth will not be predictable on a mechanistic basis.

Reading further we encounter the statement: "but populations may not so increase [according to the logistic S curve, the brackets are mine] unless they are in fact sensitive to fractional increases in population pressure, as the formula requires." Is this not an example of the not uncommon fallacy of thinking that a "fitted equation" is necessarily a true expression of the real mechanism of a reaction? I can assert from actual experience with "mechanistic" mathematical analyses of insect population growths that an S-shaped curve can seldom be adequately explained on such simple grounds.

As to the further statement, that "it is astonishing, but a fact, nevertheless, that the measure of difficulty the generation of 1790 had in rearing its children in America should have gauged accurately the ultimate and largely unutilized resources of so great a country," it is certainly very surprising, if true, but I believe it can be shown to be incorrect on mathematical grounds.

It can further be shown by mathematical analysis that the exhaustion of resources is by no means the only factor capable of permanent alteration in a population curve. To state that the exhaustion of resources is such a sole factor is to say that if N be the number of individuals in a population at time T, and R the amount of as yet unutilized resources, then N is a function only of R, and so we may write $\frac{dN}{dR}$ as a total derivative, an hypothesis hardly likely to lead to any very complete insight into the mechanism of growth of a population.

Again a change in the form of activity of a population may do far more than change the limiting value; it may change the whole form of the curve, so that, instead of approaching some limiting value as an asymptote, it commences to oscillate between two limits, with constant amplitude. It may even exhibit a damped fluctuation.

It seems to me also that the statement that the effect of the varying rate of immigration into the United States has been nil is erroneous. It has certainly had an effect, but one would hardly expect to detect it by the rather crude method of comparison with a purely empirical curve, especially as the variations are at best small in comparison with the total growth in population from census to census.

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[1] Published with the approval of the director as Miscellaneous Paper No. 10 of the Experiment Station of the Association of Hawaiian Pineapple Canners, University of Hawaii.

In conclusion, I would point out that evolution is only to be considered a negligible factor in the growth of populations of short duration, because its operations are slow. Surely, however, it must have had an effect upon the growths of the comparatively undisturbed populations of prehistoric days.

JOHN STANLEY

THE GROWTH OF STALACTITES

ANOTHER example of the formation of stalactites from the lime mortar used in a brick arch, under conditions similar to those described by Professor Ellis in SCIENCE for January 16, 1931, and by me in SCIENCE for April 10, 1931, has just come to my attention.

In sinking a well near Put-In-Bay, Ohio, on South Bass Island in Lake Erie, north of Sandusky, in 1897, the workmen broke into an unusually large vug lined with crystals of celestite. In 1901 a winding path for descending into the vug was constructed in order to make this vug available for exhibition purposes as the "Crystal Cave" and a brick arch was built over this passageway, both to give a more cave-like effect and to prevent surface material from washing in.

Surface waters, percolating slowly through the mortar joints of this arch, began the formation of stalactites immediately after its completion. This growth has been allowed to continue undisturbed for the past 30 years, until now the largest stalactites have attained a length of about six inches. Thus the rate of growth at Put-In-Bay is indicated quite accurately and, according to the data available for Fort Pickens, Fort Delaware, and Put-In-Bay, the rate of growth in all three instances is of the same order of magnitude.

The rainfall at Put-In-Bay is rather less than the rainfall at Fort Pickens and at Fort Delaware. It also appears that the rate of growth of stalactites at Put-In-Bay is somewhat less, but the relation between rainfall and rate of growth of stalactites in these cases may be no more than a coincidence. Without further information as to other factors it would be unsafe to assume that rainfall is the dominant factor in determining the relative rates of stalactite growth in these cases.

Stalactites and stalagmites, growing under purely natural conditions, are found in other caves in the vicinity of Put-In-Bay, but I have been unable to obtain information as to their rate of growth.

GRAGG RICHARDS

SPECIAL CORRESPONDENCE

FIELD ANTHROPOLOGY IN AUSTRALIA

FOR some years the Rockefeller Foundation has supported anthropological research in Australia. One of the chief centers of activity has been at the University of Adelaide, and during the last four years various expeditions have been undertaken by its board of anthropological research. The members of the most recent of these have just returned from Central Australia, where they have been successful in adding to our knowledge of the native Australian.

The locality chosen for this expedition was Cockatoo Creek, a spot about two hundred miles northwest of Alice Springs and about one hundred miles west of the geographical center of the continent. The site was beyond the country stocked with cattle; it was still occupied by a scattered population of more or less nomadic aborigines, entirely dependent for their subsistence on their own resources, unable to speak English, and in the majority of cases without having had any previous direct contact with Europeans.

Awaiting the expedition's arrival, a large number of natives, comprising chiefly members of the Ilpirra and Anmatjera tribes, but including a few Kukatja, Ngalia, and Walmala folk, had been assembled, and others arrived during their stay; in all, about one hundred and fifty individuals—men, women and children—were gathered together, having heard of our pacific intentions and being attracted by the novelty and by the promise of food in abundance. Amongst the tribes thus collected were members of one which only a few years ago had been responsible for the killing of one European and for attacks on others. Later, several reprisals had been taken by the police and a number of natives had been killed. To the expedition not the slightest sign of hostility was exhibited; the most cordial relations were established. The serious business of the scientific investigations was lightened by the good temper of the natives and leavened by their keen sense of humor. There was not the slightest suspicion that any malicious and magical use might be made, by members of the expedition, of the blood that was abstracted for blood-grouping, or of the samples of hair that were taken. They submitted with docility to tests that try the patience of Europeans.

Like previous expeditions undertaken by the University of Adelaide, teamwork was a feature of the one to Cockatoo Creek. Its personnel consisted of Dr. T. D. Campbell (organizer) and Mr. H. Gray, a student of medicine, whose work consisted of routine anthropometry, dental investigations, etc.; Professors J. B. Cleland and T. Harvey Johnston (blood-grouping, pathological conditions, etc.); Professor C. S.

Hicks and Dr. R. F. Matters (basal metabolism and physiological observations); Dr. R. H. Pulleine and Dr. H. K. Fry (observations on the special senses and psychological tests); Mr. N. B. Tindale (ethnologist to the S. A. Museum) made notes on the ceremonials, investigated each individual's tribal history, and so on; Mr. H. Hale (director of the S. A. Museum) was responsible for plaster casts; and photography, both cinematographic and still, was in the hands of Professor H. J. Wilkinson and Mr. O. Stocker.

As in previous expeditions undertaken by the board of anthropological research, the present one was carried out with the cooperation of the South Australian Museum. A considerable portion of the expense was borne by that institution and it took the opportunity of sending its taxidermist, Mr. A. Rau, with the expedition. The S. A. Museum secured a number of ethnological objects of considerable value, as well as a large number of natural history specimens.

The results of the expedition will be published from time to time in various channels as the work is completed. All that can be given at present is a very brief summary indicating the nature and scope of the information obtained. Particulars were then taken as to the individual's native name, tribe, class, totem, number of children, etc. Such details were obtained on ninety individuals. The native then passed on for routine measurements; these were carried out on thirty-three adults and comprised approximately fifty entries on cards for each person. Not only were standard measurements taken, but in addition, notes were made on the color of the skin, the eye, the hair, the condition of the teeth, etc. The hair tracts of twenty-four children were delineated. Special nasal measurements and notes on facial features were made on forty-nine adults. Physiological observations were obtained, on twenty-five individuals, of the rate of absorption of 0.9% sodium choloride by the subcutaneous tissues, and of the changes of pulse rate and body temperatures with atmospheric temperature. The spinal curvature of thirty-four adults was recorded diagrammatically, and at the same time similar records were taken of most of the Europeans temporarily present at Cockatoo Creek. Foot outlines were obtained of twenty-five grown-up natives and notes on the hands and feet of four. Records of palmar skin creases were made of forty-nine.

The individual then passed to be blood-grouped, the blood being obtained by puncturing an ear-lobe; ninety individuals were grouped, of whom sixty-four belonged to Group A, and twenty-six to Group O. In addition, a large number of cross tests were carried out between European red cells and native sera, and between native red cells and native sera. In all, the number of observations on blood-grouping amounted to approximately one thousand.

The basal metabolism was estimated on forty-two individuals (four tests on each) on whom were measured pulse rate, respiration rate, blood pressure, skin temperature and mouth temperature. The temperatures and pulse rates showed some interesting features. In the cold early morning, the mouth temperatures of natives were found to be as low as under 96°, and in some cases, the pulse rate was as low as forty-five per minute. The metabolic picture was computed by wet and dry bulb thermometer and kata thermometer readings throughout the day. Seven individuals had gum paper applied to the surface of the body with the object of ascertaining the surface area of the body—a long and unpleasant task, but one which was submitted to gracefully by the natives concerned. Other physiological observations included measurements of strength of the grip, of the back and of the legs, in sixty-six individuals. Pressure pain was measured on twenty subjects and thermal pain on ten. Visual acuity was tested on ten; forty-eight were tested on color blindness by means of Stilling's Tables. No case of color blindness was detected. Color discrimination was ascertained by Holgren's Wools, in twenty-one individuals, and this was checked by detailed observations of color nomenclature on thirteen. Seven observations of auditory acuity were made. Several attempts were made to determine the discrimination of warm surfaces at different temperatures, but no consistence could be obtained. The acuity of the sense of smell was tested on seventeen individuals; taste sensation was observed in five cases with solutions of sugar, salt and vinegar. Special perception was tested in the discrimination of numbers. Some native drawings were made on the structure of the eye, nose, and throat; observations were also made on the methods of technique in manufacturing string, weapons and utensils. General observations were made on social behavior and emotional expression.

Plaster casts were made of the faces of seventeen individuals, of the chests of three men and three women, of the hands of two persons and of the feet of two, and of body scars. Also two casts were secured of that interesting pathological condition, boomerang leg. Standard photographs (192 in number) were taken of most of the natives present, and, in addition, a large series of other still photographs as of special parts such as the eyes (15), the nose (12), and mouth, or pathological lesions (six instances), as well as incidents in the daily life of the natives and in their surroundings (forty-eight photographs). Similarly, cinematographic films were made, illustrating the daily occupations of the natives, corroborees, the method of hunting suros, and the manufacture of utensils from the wood of the bean tree (*Erythrina vespertilio*). Altogether, approximately 273 official photographs were taken, and about 1,000 feet of large track (35 mm) cinema film, and 2,200 feet of small track (16 mm) cinema film, 200 feet being in color. In addition, individual members obtained a large number of photographs illustrating native life and the natural features of the country.

Observations and notes were made upon a series of corroborees which arose spontaneously during the expedition's visit. Notes were collected of the customs and behavior of the natives; a vocabulary of approximately three hundred words was obtained. The native names for various identified trees and shrubs were also collected. Only two or three cat's cradles were known by these natives. About a dozen phonograph records of songs were obtained.

J. B. Cleland

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CONCENTRATING PARAMECIUM AND ROTIFERS WITHOUT CENTRIFUGING

The following methods have been developed and observations made while experimenting with a pure line of *Paramecium multimicronucleatum.* Rotifers will respond to the same concentrating methods in a similar manner, and it may well be that other protozoans and small metazoans will do likewise.

Infusions are prepared by boiling one gram of hay in 700 cc of distilled water for ten minutes. Such infusions are seeded with Paramecium on the second day, and are allowed to stand until a reasonably dense population of animals has developed. Usually this requires ten or more days.

Such cultures are then redistributed among glass containers of any size which have the approximate surface-to-volume ratio of an ordinary quart jar. No container should be more than half full of the infusion. Containers which have straight sides, while not necessary, are more desirable for this stage of the operation. To each of these containers is added an amount equal to the quantity of culture present of cooled infusion freshly made according to the formula given above.

The populations of these new infusions will be forced to congregate at the surfaces in bands on the sides of the containers during the next two or three days. From time to time they may be picked up with a fine pointed pipette and transferred to concentration tubes. The tubes used in these experiments were 30 centimeters long and had an internal bore of eight millimeters. Although the tubes used were of the dimensions indicated, it is probable that a considerable variation would not affect the result. While the collecting is in progress, excessive concentration in any one tube must be avoided, if all the animals collected are to remain alive. Each tube should have an air space of at least five centimeters at the top.

Final aggregation is brought about by shaking the concentrations in the tubes violently in such a manner that the bubble of air is forced to pass back and forth through the columns of infusions. If the tubes are then set aside in a vertical position, the organisms will settle to the bottom. The infusion above the aggregation of animals may be removed with a capillary pipette if a dense mass of protoplasm is desired, or it may be poured off if so complete a concentration is not needed.

The above method is efficient to the point that we have collected a volume of seven cubic centimeters of living Paramecium from five containers, each of two gallons capacity. The instructor who desires to concentrate a few thousand animals for laboratory demonstration will find that two quart jars will supply an ample crop for the most wasteful freshman laboratory.

There are several short cuts by which a concentration may be obtained more quickly if cultures in the proper condition are at hand. For example, the population of an old Paramecium culture can be forced to the surface by the addition of fresh infusion to it. This would save at least ten days. Again, if a middle-aged culture in which the animals have settled to the bottom of the culture is at hand, the animals can be concentrated by repeatedly drawing a long fine-pointed pipette through the débris on the bottom and emptying the material secured into concentration tubes. The hay settles to the bottom. The Paramecium will be forced out of it, and upward, until they reach the surface, if the tubes are allowed to stand undisturbed in a vertical position over night.

Usually an adequately concentrated supply of Paramecium for one or two laboratories can be secured directly from a culture by one of the methods described above, without the use of tubes. Such material can be very nicely kept in syracuse dishes. However, if one desires to supply a series of laboratories, it is advisable to use the tubes, as the Paramecium can be fed daily by shaking to force them to the bottom, pouring off the old infusion, and adding new.

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A SIMPLE PHOTOMICROGRAPHIC APPARATUS FOR OBTAINING DEPTH OR FOCUS

THE generally prevailing use of the camera lucida as a means of illustrating Ostracoda, Foraminifera, insects and kindred small sub-spherical bodies evidences a difficulty commonly met with in achieving satisfactory photographic realization in combination with magnification. This is essentially due to the inability of the microscope's objective to provide depth of focus. The apparatus here described was constructed from the suggestions of Professor Albert Johannsen, of the University of Chicago. It furnished a magnification of from 12 to 28 diameters, depending upon the lens used, and was employed with excellent results in picturing the heads of flies and the wings and limbs of small insects. It proved satisfactory for the photographing of Ostracoda large enough to be retained by a forty-mesh screen, and offers the possibility of photographing even smaller ones.

The bellows of a good 5″ by 7″ view camera was extended by attaching to it an elongated wooden box, made by nailing together four boards, each eight inches wide by ten feet long. Cardboard diaphragms, properly sized, and containing circular openings four inches in diameter, were inserted into the box at distances of one third and two thirds of its length, respectively, to cut off any light reflected from its sides. The ground-glass plate and the plate-holder of the camera were then mounted in a cardboard support and fastened to one end of the tube, the seam being made light-proof by wrapping securely with black cloth. In a similar manner the bellows and lens of the camera were attached to the opposite end of the tube, and the whole apparatus firmly mounted upon a long table. Focusing was accomplished by means of the rack and pinion of the view camera. It required considerable care and precision, since very slight alterations of the distance between the lens and the object produce great changes in the focus on the ground-glass. Powerful illumination is essential, and two 250 candle-power bulbs, placed about eight inches from the object, were employed for this purpose. Under these conditions the time of exposure was between five and six minutes.

Since the size of the image obtained is a function of the length of the bellows extension, considerably higher magnification may be achieved by increasing the length of the wooden tube.

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SPECIAL ARTICLES

CHEMICAL STUDIES ON TOAD POISONS, IV, BUFAGIN AND CINOBUFAGIN

DURING the past three years Dr. K. K. Chen and I have been studying toad poisons from both a chemical and pharmacological point of view. Due to the difficulty of obtaining somewhat large amounts of material the work has been rather slow. The isolation of the various principles from Ch'an Su, the dried venom of the Chinese toad, and from *Bufo marinus* has been reported[1]. A thorough pharmacological study of cinobufagin, isolated from Ch'an Su and of Abel's bufagin, isolated from *Bufo marinus*, undertaken by Dr. Chen, revealed that their physiological action is qualitatively about the same as that of the cardiac plant glucosides, but that there is a quantitative difference. The results of the pharmacological study of the principles isolated from Ch'an Su have been published[2]. These pharmacological findings make it appear very probable that the principles of toad poisons are chemically also very closely related to the cardiac aglucones of the plant kingdom. The reported formulae for cinobufagin $C_{29}H_{38}O_7$ (1c) and for Abel's bufagin $C_{28}H_{36}O_6$ (1d), however, do not indicate any close chemical relationship to the plant cardiac aglucones, which are C_{23} derivatives, as has been shown by Jacobs and coworkers[3] and by Windaus and coworkers[4]. Further investigation, and especially a careful analytical study of various derivatives of cinobufagin and bufagin, have led to the revision of the above formulae and the following ones are proposed, cinobufagin $C_{25}H_{32}O_6$ and bufagin $C_{24}H_{32}O_5$. The published analytical data check very well with these revised empirical formulae.

Cinobufagin, $C_{25}H_{32}O_6$, when treated with alkali, gives rise to a hydroxy-carboxylic acid with the opening of a lactone ring and the splitting off of acetic acid. On acetylation one acetyl group is introduced into the molecule. Under the influence of hydrochloric acid water and acetic acid are split off. On oxidation with chromic acid a mono-ketone is formed. From the foregoing one can conclude that the molecule of cinobufagin contains a lactone, an acetoxyl, a secondary hydroxy and a tertiary hydroxy group, thus accounting for the six oxygen atoms in the molecule. On catalytic reduction tetrahydrocinobufagin is formed, thus indicating the unsaturated nature of cinobufagin.

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[1] (a) K. K. Chen and H. Jensen, *Proc. Soc. Exper. Biol. and Med.*, xxvi, 378, 1928–1929; (b) H. Jensen and K. K. Chen, *Jour. Biol. Chem.*, 82, 397, 1929; (c) *ibid.*, 87, 741, 1930; (d) *ibid.*, 87, 755, 1930.

[2] K. K. Chen, H. Jensen and A. Ling Chen, *J. Pharmacol. and Exper. Therap.*, 43, 13, 1931.

[3] W. A. Jacobs and E. L. Gustus, *Jour. Biol. Chem.*, 78, 573, 1928.

[4] A. Windaus, K. Westphal and Y. Stein, *Ber. d. deutsch. Chem. Gesell.*, 61, 1847, 1928; A. Windaus and Y. Stein, *ibid.*, 61, 2436, 1928.

Bufagin, $C_{24}H_{32}O_5$, when treated with alkali, forms a hydroxy-carboxylic acid with the opening of a lactone ring and splitting off of formic acid. On acetylation one acetyl group is introduced. Under the influence of hydrochloric acid formic acid and one molecule of water are split off. Several attempts to secure a ketone by oxidation with chromic acid have failed. From these findings one may conclude that the molecule of bufagin contains a lactone, a formoyl and a tertiary hydroxy group, thus accounting for the five oxygen atoms in the molecule. On catalytic reduction tetrahydrobufagin is formed, indicating that bufagin is also of unsaturated nature. Catalytic reduction of cinobufagin and bufagin also gives by-products of acid character, probably formed by the opening of the lactone ring.

From the foregoing one can see that the chemical behavior of cinobufagin and of bufagin is quite similar to that of the plant cardiac aglucones. By splitting off the acid radical which is attached to a hydroxy group (acetic acid from cinobufagin and formic acid from bufagin), one obtains compounds which are C_{23} derivatives, as are the aglucones of the plant glucosides.

$$C_{25}H_{32}O_6 \xrightarrow{+H_2O} C_{23}H_{30}O_5 + CH_3COOH$$
Cinobufagin

$$C_{24}H_{32}O_5 \xrightarrow{+H_2O} C_{23}H_{32}O_4 + HCOOH$$
Bufagin

While the cardiac poisons of the plant kingdom are combined with carbohydrates these principles of toad poisons are coupled with acetic acid or formic acid, or, as in the case of the nitrogen containing principles, which also have a cardiac action, with suberylarginine and an acid radical.

It has already been mentioned that bufagin under the influence of hydrochloric acid will lose formic acid and one molecule of water.

$$C_{24}H_{32}O_5 \xrightarrow{HCl} C_{23}H_{30}O_3 + HCOOH + H_2O$$
Bufagin Bufagien

Bufagin is a mono-hydroxy lactone containing three double bonds and should give on catalytic reduction a compound of the composition $C_{23}H_{36}O_3$. It is hoped that the latter substance may be identical with one of the known reduced anhydro compounds of the cardiac aglucones of the plant glucosides[5]. If this should be true it would be a direct proof of the chemical relationship between these two groups of natural compounds. This reaction is now being carried out and attempts are also being made to convert cinobufagin by similar steps into the corresponding compound. The results so far obtained and those which are being accumulated will be published later in greater detail.

Another method of approach to show the possible chemical relationship between the cardiac principles of toad poisons and those of the plants may be as follows: Bufagin and cinobufagin are converted with alkali into the corresponding hydroxy-acids and these are then catalytically reduced, giving C_{23} derivatives, which may be identical with compounds obtained from the plant aglucones in a similar manner. This method is being investigated.

The author wishes to express his thanks to Dr. K. K. Chen of the Lilly Research Laboratories, Indianapolis, for the supply of Ch'an Su and the secretion of *Bufo marinus*. The author is also indebted to Mr. Hutchison of the Antivenin Institute, Glenolden, Pennsylvania, for an additional supply of the secretion of *Bufo marinus*. The research has also been aided in part by a grant from the Committee on Scientific Research of the American Medical Association.

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CRYOLYSIS OF LYOPHILIC COLLOIDS, AND ITS BEARING ON THE MECHANISM OF ENZYME ACTION

IN a recent publication[1] evidence has been furnished that the surface tension of a solution containing lyophilic biocolloids is increased by ethylene as well as by acetylene. At the same time the observation was made that the viscosity of the same solutions was decreased. These observations were interpreted on the basis that ethylene or acetylene are in a state of physical adsorption on the surface of the lyophilic colloids. The gases exert accordingly a protector action on the combined carrier-enzyme surface, the latter being increased when submitted for shorter or longer time to the influence of freezing.[2] In order to obtain a detailed information of the latter observation solutions of different concentration of egg albumin, gelatin, gum arabic and sodium oleate were investigated by means of cryolysis. The measurements of the surface tension of all the solutions in all concentrations, having been frozen once or repeatedly at different temperatures, furnished a decided increase. The viscosity, however, was decidedly increased solely in the case of egg albumin, decreased when using solutions of gelatin or gum arabic and immaterially influenced in the case of sodium oleate solutions. The electrical conductivity of solutions in the range of a concentration of 0.01 per cent. was decidedly increased, whereas in a concentration above 0.1 per cent. it was decreased, and finally the speed of cataphoretic mobility of the colloid particles, when measured in solutions of gelatin and egg albumin, was practically doubled after freezing.

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[5] See reference 4; W. A. Jacobs and A. M. Collins, *Jour. Biol. Chem.*, 63, 123, 1925; W. A. Jacobs, R. C. Elderfield, A. Hoffman and Th. B. Grave, *J. Biol. Chem.*, 93, 127, 1931.

[1] F. F. Nord, *Trans. Faraday Soc.*, 26: 760. 1930.

[2] F. F. Nord, *Nature*, 120: 82. 1927.

The fact that the values of viscosity determinations were decreased in some cases, but the values of surface tensions, however, showed a thoroughgoing increase, may be understood if we recall that, for instance, a zymase solution or a gelatin solution may be considered as in every respect a more heterogeneous system, when compared with a solution, for instance, of egg albumin. It is necessary, therefore, to assume that under the effect of freezing, lyophilic colloids not only may undergo a disaggregation of the colloid particles, but also an aggregation of the same.

In so far as the values of surface tension measurements are concerned, we noticed that the reapproachment to the value of the surface tension of conductivity water was the greater, the more the respective solutions were diluted. In order to understand this fact we may assume, in accordance with the considerations of Gortner and coworkers[3] concerning the bound ⇆ free water equilibrium, that the surface tension of a lyophilic colloid solution is a resultant of three factors. namely, (a) the surface tension of colloid particles, and (b) the surface tension of the aforementioned two parts of the water system. Under the assumption that the increase of the value of surface tension of a frozen and afterwards thawed solution of lyophilic colloids, if not caused by dehydration of the particles, is due to a decrease of the radius of the colloid particles and subsequent increase of the surface of the same, then the bound ⇆ free water equilibrium is shifted in disfavor of the free water component. Accordingly, the surface tension increases only to the extent of the difference between the surface tension value of the particles and the value of surface tension of the water system. The diluted solutions on the other hand contain less particles, and accordingly the additional amount of bound water, when the surfaces are increased on account of freezing, as well as the difference between the value of the particles and the value of water, is smaller. The increase of the value of the surface tension is therefore greater in the case of diluted solutions. It was noticeable in this connection that sodium oleate solutions showed a decided diminution of volume in frozen state, compared to the unchanged volume of frozen proteins or gum arabic. This observation may be due to the possibly much less material rôle of the bound water in the case of colloidal electrolytes.

The disaggregation-aggregation hypothesis is supported also by the results of the measurements of conductivity and cataphoretic mobility of the particles, since we assume that the conductivity of dispersoid systems, containing the same amount of substance in dispersion of different degree, is reciprocally related to the square of the radius of the particles. The conductivity itself is based on the particles of highest dispersion of the system. The increased cataphoretic mobility on the other hand may be due to the fact that on account of increased dispersion, electrolytes went into solution out of the proteins, causing an electrical charge of the particles, which again causes an increase in their mobility.

Since, according to our present knowledge, proteins have to be considered not only as the substance of crystalline enzymes, but also as being responsible for the properties of the so-called carriers, so we may consider the results of our measurements as the first exact proof of the colloidal carrier's dependence of functioning on its physical state. At the same time it may be also mentioned that the biochemical behavior of physically transformed lyophilic colloids is distinctly different from the original systems.

It is intended to report in detail the experiments in the *Kolloid Zeibschrift*.

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SEX DIFFERENCES IN THE STUDY OF GENERAL SCIENCE

THE purpose of this study is to investigate sex differences in the difficulty of the course in ninth-grade general science, and variations in difficulty from one part of the course to another.

Since competent writers of general science text-books do not agree upon what to include in the course, the selection of material for investigation must necessarily be arbitrary. Seven hundred forty-eight statements were chosen from text-books commonly adopted, the intention being to obtain a varied and random sampling of material sometimes used. To validate the use of these statements, ten text-books were surveyed to discover the extent to which these statements were incorporated into the course. A statement was counted as being in a book if found stated directly or if material was found from which it could be readily deduced. Table I summarizes these findings.

This list of statements agrees as well with the text-books as they do with each other and is better justified than a list of statements found in all text-books, since

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[3] R. A. Gortner, "Outlines of Biochemistry," p. 230, New York, 1929.

TABLE I

Author	Text	Edition	Statements found
Hessler	First Year of Science	1925	615
Hunter and Whitman	Problems in General Science	1930	612
Van Buskirk and Smith	Science of Everyday Life	1928	598
Wood and Carpenter	Our Environment—How We Use and Control It	1927	567
Caldwell and Curtiss	Introduction to Science	1929	566
Webb and Didcoct	Early Steps in Science	1924	552
Snyder	General Science	1925	532
Pieper and Beauchamp	Everyday Problems in Science	1925	508
Hodgdon	Elementary General Science	1928	442
Clark	New Introduction to Science	1928	364

only 150 of the 748 statements were used by every author. Text-book writers agree least on plant and animal biology, on biographical material and on foods and clothing. They agree best on heat, electricity and weather. Some authors omit entirely large bodies of material included by most of the others.

The statements were converted into completion or recall questions. C. I. Hull (Aptitudes Testing, New York, World Book Co. Page 313) reports that the self correlation of various forms of tests is: true-false r equals .507, multiple-choice r equals .556, completion r equals .618. Completion also lessens the chance of neighboring questions affecting the test item by eliminating needless words used as alternates in multiple-choice questions. Completion questions can not be answered by eliminating the wrong answers.

Subjects tested were chosen by the selected sampling method from six widely scattered states, all in the North except Virginia. School enrolments ranged from less than one hundred to more than two thousand in a single building. Farming communities and one select city residential district supplied the pupils tested. Three hundred boys and three hundred girls supplied the material used for calculating the difficulty of the questions. The tests were given at the end of the year, after a period of review, by the class teachers under uniform conditions. The papers were scored uniformly by the experimenter.

Since the content of general science is not standardized, the questions were classified in terms of the science from which they were originally derived. An adequate classification is difficult because a single statement may be used in any one of several contexts. For instance, carbon dioxide is discussed under atmosphere, chemistry, foods, fire extinguishers, respiration, ventilation, oxidation and geology. Questions were finally classified on the basis of their occurrence in other secondary science books, as physics, chemistry, physiography, etc.

The per cent. of pupils who missed each question was calculated separately for boys and girls. For each question the per cent. of boys missing the question was subtracted from the per cent. of girls missing the question. That is, a question missed by 84 per cent. of girls and 76 per cent. of boys would yield a *difference* of plus 8, indicating the question is easier for boys than for girls. Minus differences indicate the questions are easier for girls.

Table II shows the distribution of the 748 questions arranged in order of the difference in difficulty for boys and girls. Only 14 questions were equally difficult for both, 187 were from 0 to 4.9 per cent. easier for boys, etc. The median question in this distribution has a difficulty difference of plus 5.06.

TABLE II

DISTRIBUTION OF DIFFERENCES IN DIFFICULTY FOR BOYS AND GIRLS

Minus class intervals										
34–30	29–25	24–20	19–15	14–10	9–5	4–0	0			
N1	1	2	7	11	42	107	14			
Plus class intervals										
0–4	4–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54
N187	170	78	58	31	18	8	7	5	0	1

Table III shows the median difficulty of the questions when arranged in groups. Of the twelve questions on clothing, the median question was 3.3 per cent. points easier for girls than for boys. Read downward the topics become increasingly difficult for girls and increasingly easy for boys, relatively.

The differences are significant when the median is three times its probable error. Only three subdivisions of material fail to show significant differences, while thirteen of eighteen favor boys.

The mean of the 748 differences is 6.1 per cent. points, counting as minus differences favoring girls.

Typical questions on which girls excel are: Artifi-

TABLE III

MEDIAN DIFFICULTY OF QUESTIONS UNDER SUBDIVISIONS

Type of material	Number of questions	Median difference	P.E.$_{sd}$
Clothing	18	− 3.3	.5
Food	27	− 2.8	.9
Earth, weather, geology	79	.1	.4
Human biology, health	60	.6	.5
Life processes and development	20	1.9	.7
Properties of matter	8	2.5	.8
Plant and animal biology	49	2.8	.7
Biography	34	2.9	.6
Astronomy	19	3.2	.8
Light	51	4.0	.8
Chemistry, air, water, matter fuels	115	4.4	.4
Heat	48	6.0	.7
Simple machines, work, laws of mechanics	50	6.4	.9
Sound	19	9.9	1.8
Measurement, introductory method	19	11.2	1.6
Fluids, barometers, pumps	32	11.9	1.1
Electricity	68	12.0	.9
Applied mechanics, engines, etc.	38	22.2	1.3

cial silk made from wood pulp is called rayon; iodine mixed with starch gives a dark blue color; a disk one third red and two thirds yellow appears to be orange when rotated rapidly.

Boys are superior to girls in answering these: Lamp cords are insulated with cloth and rubber; a dry cell is contained in a zinc can; an airplane with two sets of wings is a biplane.

Apparently a large part of the differences can be explained by environmental factors differing in the experience of boys and girls. These factors may or may not explain the much greater interest of boys in mechanics. At any rate, sitting in the same classes, reading the same text-books, receiving instruction from the same teachers do not operate effectively in eliminating sex differences.

This study brings out more questions than it solves. Should we shift emphasis on the course for boys and for girls to attempt to equalize their achievement? Is one course over mechanics adequate for a girl who must live in houses and offices dominated by machines? Do sex differences carry over to teachers of general science? What advanced sciences should be provided for girls, since they are so obviously handicapped in physics? Should boys and girls be taught separately since their interest as manifested in achievement is considerably different? Should boys and girls be graded on the same distribution?

CONCLUSIONS

General science is far from standardized in textbook treatment, the range of completeness being from 48 per cent. to 82 per cent. of a random checklist of items.

Material in general science is not arranged in either uniform or logical manner.

Material generally covered in biology shows no sex difference in general, but the subdivisions show slight differences.

Physiography material shows no sex differences.

Chemistry material shows significant differences in favor of boys.

Physics material is much easier for boys than for girls, the median differences on subtopics ranging from 4 to 22 per cent.

The subject as a whole is much easier for boys than for girls.

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PROGRESS IN WESTERN DUCK SICKNESS STUDIES

A RECITAL of the events and experimental work that have led to a new concept of western duck sickness, formerly attributed to the toxic action of certain soluble salts of "alkali," was published in SCIENCE late in 1930.[1] The findings there chronicled strongly suggested that a type of botulism was involved. A supplementary contribution by Drs. Giltner and Couch,[2] appearing at the same time, set forth the fact that the bacillus of *Clostridium botulinum*, Type C, was present in mud obtained at Tule Lake, California, as well as in the tissues of wild mallards, pintails and ring-billed gulls that had died of or were killed while afflicted with duck sickness.

Despite the highly suggestive character of these circumstances and other facts revealed, including the striking similarity of the syndrome of duck sickness and that of botulism as manifested in "limberneck" of domestic ducks, there still remained the necessity of demonstrating actual toxin production under field conditions, and in media or associated with food or water likely to be ingested by birds. With an organism as prevalent and widely distributed as *Clostridium botulinum*, the need for such added evidence is obvious. As expressed by Geiger, Dickson and Meyer,[3] "the mere isolation of this organism from the suspected feed or intestinal tract or spleen of a dead animal is insufficient to support the diagnosis of botulism." There is always the likelihood that tissues may be invaded after death by this saprophytic anaerobe which, in the form of a few adventitious spores, may have been making harmless passage through the alimentary tract at the time of the creature's death, brought about by factors that may have been wholly foreign to botulism.

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[1] E. R. Kalmbach, "Western Duck Sickness Produced Experimentally." SCIENCE, lxxii, 1878, 658–659, Dec. 26, 1930.

[2] L. T. Giltner, J. F. Couch, "Western Duck Sickness and Botulism." *Ibid.*, 660.

[3] J. C. Geiger, E. C. Dickson and K. F. Meyer, "The Epidemiology of Botulism," U. S. Public Health Bulletin No. 127, pp. 1–119, September, 1922.

Demonstration of toxin in the field, therefore, in concentrations lethal to birds and in, or closely associated with, likely food items, constituted the primary objective of the past season's study of duck sickness conducted by the Biological Survey in southern Oregon and northern California. It was the logical sequel to the progress made in 1929 and 1930, and it constituted the final unforged link in the complete chain of evidence. Without such toxin demonstration the concept of botulism being the cause of duck sickness still would remain, at least to the bacteriological world, an unproved theory.

It is gratifying to be able to announce that this primary objective was attained, not once, but in at least twenty different instances during the summer of 1931. In each case toxin was demonstrated by the feeding or inoculation of experimental birds (mainly pigeons) with material obtained directly from field sources. Necessary toxin-antitoxin tests were made on every occasion, definitely identifying the toxin as that originating from *C. botulinum,* Type C, of Bengtson.

The media in which toxin was demonstrated included the bodies of birds dying of duck sickness, mud in the immediate vicinity of such bodies, water from shallow pools in infected areas, living and dead larvae of sarcophagid flies, submerged barley and other grains that had lain on mud flats where they were subjected to high temperatures and an alkaline environment. Under conditions that were strictly experimental but which might easily occur in the field, toxin also was demonstrated in a mixed mass of insect remains, copepods, snails, algae and Lemna. The organism, but not its toxin, was also demonstrated in such apparently suitable toxin-producing media as the dead larvae and pupae of hydrophilid beetles, submerged wheat heads of the season's crop, colonies of dead copepods, and miscellaneous insect débris, drifted ashore by wave and wind action.

This array of demonstrated toxin-producing media, though admittedly only a beginning, already includes food items that would indicate the channels through which ducks and shore birds may contract the trouble. Added research we feel is destined to extend the categories of toxin-producing food items of these two groups of highly susceptible birds and, bit by bit, round out our knowledge of the sources and vehicles for the toxin now known to affect more than sixty species of wild birds.

During 1931, progress also was made in the study of other aspects of this problem. Mentioning only a few, attention may be called to the apparent and doubtless important correlation between the incidence of duck sickness and alkalinity; the presence of Type C to the almost if not total exclusion of other types of botulism in duck sickness environments; the degree of susceptibility of lower organisms, both vertebrate and invertebrate, the death of which in the course of an outbreak of the disease would greatly augment the quantity of toxin-producing media; the toxin-destroying properties of high concentrations of certain alkaline salts and the possibility of thus explaining the absence of duck sickness from certain areas otherwise suited to its occurrence. These and numerous other aspects of the problem, mainly bacteriological in character, bid fair to make future studies of duck sickness of as great importance to the bacteriologist as to the conservationist of wild life.

During the season of 1931 Mr. M. F. Gunderson, employed by the Disease Investigation Project of the Biological Survey, worked with the writer, and to him is due great credit for the progress made along bacteriological and toxicological lines. At present he is continuing these studies in the department of bacteriology and immunology, University of Minnesota. It is a fruitful field for pure research as well as for the attainment of results of great practical value in the preservation of wild birds, and it stands to reason that, before the story of western duck sickness is completed, earlier concepts of the disease as well as the prevalence, range and economic importance of *Clostridium botulinum,* Type C, will be greatly changed.

E. R. Kalmbach

Biological Survey,
U. S. Department of Agriculture

BOOKS RECEIVED

Annual Report of the Board of Regents of The Smithsonian Institution. Pp. xii + 650. Illustrated. United States Government Printing Office. $2.00.

Browning, Ethel. *The Vitamins.* Pp. xxxii + 575. Williams and Wilkins.

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International Address Book of Botanists. Pp. xv + 605. Braillière, Tindall and Cox. London. 12s. 6d.

Rorimer, James J. *Ultra-violet Rays and Works of Art.* Pp. xii + 61. 47 plates. The Metropolitan Museum of Art. $2.00.

Schairer, John F. *The Minerals of Connecticut.* Pp. 121 + vii. State Geological and Natural History Survey.

SCIENCE

Vol. 75 FRIDAY, JANUARY 15, 1932 No. 1933

Thomas Alva Edison:
An Appreciation of Mr. Edison Based on Personal Acquaintance: DR. CHARLES L. EDGAR 59
Edison's Contributions to Science and Industry: DR. F. B. JEWETT 65
Edison as a Scientist: DR. ROBERT ANDREWS MILLIKAN 68
Edison's Laboratory in War Time: DR. KARL T. COMPTON 70
Obituary:
Samuel Mather: DR. TORALD SOLLMANN. *Memorials; Recent Deaths* 71
Scientific Events:
Italian Professors and the Fascist Government; Mineral Research Program of the Illinois Geological Survey; The Journal of Cellular and Comparative Physiology; The Non-resident Lecturer in Chemistry at Cornell University 73
Scientific Notes and News 75
Discussion:
A Possible Means of Cutting down the Mosquito Population: DR. ELIHU THOMSON. *The Need for a New Experimental Approach in Immunology:* DR. THEODORE J. CURPHEY and DR. HERMAN B. BARUCH. *Rumbling Clouds and Luminous Clouds:* PROFESSOR JOHN ZELENY. *Entoptic Colors:* ELMER F. WAY. *The Prevention of Convulsions:* E. J. SHEEHY 78
Societies and Academies:
The Texas Academy of Science: H. B. PARKS 81
Scientific Apparatus and Laboratory Methods:
A Simple Suspended Mirror Seismograph: PROFESSOR BENJAMIN ALLEN WOOTEN. *Apparatus for Taking Water Samples from Different Levels:* J. ARTHUR REYNIERS 82
Special Articles:
Regeneration in Bryophyllum: JOHN A. YARBROUGH. *A New Plant Source of Vitamin A Activity:* DR. D. H. COOK and JOSEPH AXTMAYER. *A Note on the Effect of Ultra-Violet Light on the Vitamin A of Butter:* PROFESSOR CHAS. L. SHREWSBURY and DR. H. R. KRAYBILL 84
Science News 8

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THOMAS ALVA EDISON

TRIBUTES FORMING A MEMORIAL PROGRAM GIVEN AT THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AN APPRECIATION OF MR. EDISON BASED ON PERSONAL ACQUAINTANCE

By Dr. CHARLES L. EDGAR

PRESIDENT OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON

I AM deeply honored by being asked to address your association, especially upon the subject assigned to me. I note that I am to be followed by three addresses, having to do with the achievements of Mr. Edison, and it is, perhaps, fitting that I should try to give you, in the few minutes at my disposal, a somewhat personal picture of the man as an individual, a friend and an associate. This will, I hope, give a sympathetic setting to the remarks of those who come after me. If I can give you a little of the Edison atmosphere, I think I will have accomplished my purpose.

I have been associated with him or with companies that bore his name for practically fifty years, and I am afraid that, in telling you of some of the incidents connected with our acquaintanceship, I may bring myself too much into the picture. This, I fear, is unavoidable, and I therefore apologize in advance for possibly being too personal.

I was brought up in the Edison atmosphere. I spent my boyhood vacations on my grandfather's farm, located within a few miles of the renowned Menlo Park, where Edison carried on his most important work. We had to pass the laboratory in going to the nearest village, and I came to know the surroundings and the general talk of the neighborhood as to what Edison was doing. Of course his work did not mean anything to me at that stage of my life, but it was, perhaps, a fitting introduction to some of the things which came later on.

I was a student at Rutgers College in New Brunswick, located about seven miles from Menlo Park, and during my senior year two or three of us went down to the Laboratory one afternoon entirely as a matter of curiosity. A little billiard room was located next to the station, and it was in passing the window of that establishment that I first saw an incandescent lamp burning.

In walking through the machine shop, I saw a group of three well-dressed city men standing alongside one of the benches, apparently talking to a young man in overalls, who was sitting on the bench and swinging his feet. My first thought was that they had happened to stop near where this young man was sitting and that he was inadvertently listening to what they had to say. Some one nudged me and said: "That's Edison." Although I had been in the neighborhood of the laboratory, as I said before, many times as a boy, I had not happened to see him to know him until that day in my senior year.

When I graduated in 1882, I took a postgraduate course in electricity. The instruction was, of course, in those days very crude and the apparatus still more so. We had one or two rather good electric instruments, but most of the apparatus was something that we had made up ourselves. Mr. Edison's laboratory at Menlo Park was in somewhat the same condition.

Our professor in physics was quite an intimate friend of Mr. Edison, and every once in a while I was sent down to Menlo Park either with one of our instruments which Edison wanted to borrow, or to borrow one from him to try on some experiments in our own laboratory. Even on these visits I very seldom saw him, but became quite familiar with his assistants and with the general work in which they were all engaged.

In January, 1883, armed with a letter of introduction from my professor, I went down to Menlo Park to see Mr. Edison and ask him for a job. I knocked at the front door, was sent into the parlor and told to wait. For some time I heard conversation going on in the next room where the family were at breakfast. After a while the conversation ceased and at the end of fifteen or twenty minutes I began to wonder whether I had been forgotten. Apparently I had, because a few minutes later Mr. Edison walked into the parlor, with his hands in the old-fashioned pockets which men wore in those times, a cigar in his mouth, and said: "Where the dickens did you come from?"

I presented my letter which he read and then rather crisply said, "Go down to '65' and see Charlie Clark and tell him I sent you." I was nothing but a youngster and did not have the nerve to ask him for more details. I made some inquiries, however, and the next day went down to what was always called "65." This was the headquarters of the Edison interests, a handsome brownstone house on Fifth Avenue, just below Fourteenth Street, and it was for many years the Mecca of all Edison men. Charlie Clark turned out to be chief engineer of all Edison's work and he sent me down to Goerck Street, which at that time was where the electric dynamos were built.

Clark had fitted up a laboratory which, for those days, was quite elaborate. We must have in mind that, at that time, funds were rather low and elaborateness did not really mean very much. There were, however, a dozen of us, mostly college graduates, all working for glory and not for pay. In fact, the only one actually paid was Mr. Andrews, who was the head of the laboratory.

In the same way that our apparatus was crude, the work in which we were engaged was of the same character. We met with new problems almost every day. Some were solved by the construction of new apparatus and others by new methods of using the old apparatus.

It was during my six months at the Goerck Street laboratory that I came into closest contact with Mr. Edison. I could spend the whole evening telling about the various incidents which occurred which brought one or more of us in direct contact with him. I have in mind two specific events, however, which may give us some insight into this relationship.

All the dynamos were tested by our crowd and were regulated for voltage by a resistance box in series with the field, and more or less resistance was cut in by a commutator device turned by a handle. We got the idea that it was possible to have something automatic, and I personally happened to be the one to whom this work was turned over. We designed an automatic regulator, in which the movement of a small arm was actuated by the strength of magnets. The arm was fitted with a brush, which contacted with the segments of the commutator, and the weakening or strengthening of the magnets pulled in more or less resistance.

It worked very well in the laboratory and we thought we would try it on a new installation in the New York Athletic Club, which had just been built. When the current was turned on in the afternoon, the regulator worked perfectly. When, however, a large block of light was added at one time, the regulator started to race and the lights went from one half candle power to double candle power every ten or fifteen seconds. To say that I was frightened puts it rather mildly. I grabbed the rocker arm with my hand and managed to steady it so that we could get through the evening with comparatively little trouble. The next morning I went down to see Mr. Edison and told him the trouble. His reply was: "Oh, that's easy. I will send you over something in a day or two which you can put on to remedy the trouble."

The device consisted of a small cylinder with a movable piston, which had a small hole in it. The cylinder was filled with glycerine and sealed. The piston was directly connected to the rocker arm and the glycerine was forced through the small hole as the piston moved up and down. The hole was fitted with a plug, which enabled one to change its size at will, and the speed of the rocker arm was thus cut down and absolutely controllable. It seems rather foolish to explain to this audience a device which is now so well known and so simple, but you must remember that this was forty-eight years ago when most of these problems had not arisen and therefore had not been solved.

After the device arrived at the laboratory, I remember that we all put our heads together and wondered why some of us had not thought of the solution, but it remained for Edison to instantly see the problem and its solution.

As many of you may remember, the Edison system made use of the electrolytic meter for a number of years and until the mechanical meter was developed. This meter read amperes rather than watts and was a very ingenious and in fact a very simple chemical process. A number of bugs developed and I found myself more or less of a specialist on this work. While we were carrying on some of the original experiments, Mr. Edison got out what would now be called a questionnaire. He propounded about one hundred questions and passed them out one at a time to the various men in charge of the meter systems of the companies throughout the country. The replies came to me, and it was my job to classify them and to talk them over with Mr. Edison and see if we could get any ideas which would help us. I was no exception to the rule and he gave me the same questions. I have a very distinct recollection of two of his comments. I do not remember the questions, but I remember one of his comments was: "Edgar, this is no good. You ought to know better. Edison." The other was more satisfactory. He said, "Edgar, this is good. Edison"; and then, in his characteristic handwriting he wrote underneath it—"This answer is so good that I wish you would expand it a little, as I want to pass it along to the other boys." These two experiences may give you a little idea of the relationship which existed between him and those in his personal employ.

In 1884 we made a very elaborate exhibit at the Electrical Exhibition in West Philadelphia. I was there for three or four months constructing, operating and demolishing the work. Mr. Edison was a constant visitor. He seemed to take much interest in the exhibits, not only in his own but in those of other exhibitors. During its continuation it was visited by many foreign engineers, and on these occasions they were invariably accompanied by Mr. Edison.

I remember a discussion which took place one afternoon between Sir William Preece and Mr. Edison on some detail of the system which Mr. Edison was showing. They differed in their views, and it was always a source of great satisfaction to me to remember that time proved that Mr. Edison was right.

In 1885 there was a sufficient number of Edison stations established throughout the country to warrant the formation of an organization, bringing these people together. It was called the Association of Edison Illuminating Companies, and I do not believe there was a single meeting that Mr. Edison missed for at least twenty years. He, of course, was not able to take very much part in the discussion, as he was too deaf to hear well what was going on. He got a sufficient idea, however, to call us together informally between meetings and discuss privately most of the subjects which had just been presented publicly.

In some respects the most interesting part of these conventions were the trips to the convention cities. If they were any distance from New York, we usually had a private train and Mr. Edison was the life of the party. The crowd would group around him in his drawing room and he would tell stories by the hour, some of us even sitting on the floor in order to get close enough to hear what he was saying.

As I tell you this story, it does not seem as if I came in very close contact with him, but as a matter of fact, the opposite was true. His deafness prevented one from getting really intimate. In carrying on a conversation with him, it was rather embarrassing to shout so loud that every one in the room could hear you, and many is the time that I wished that we were by ourselves so that I could express myself more definitely than I could in what was really a public place.

On one of the hottest days in June, 1930, I had to go out to the laboratory and present Mr. Edison with a Memorial which had been passed by The Society for Electrical Development. After making the presentation and chatting for three or four minutes, Mr. Meadowcroft, Mr. Edison's secretary, suggested, as he usually did, that we go outside and have our photographs taken. This picture was published in the Boston papers on the day of Mr. Edison's death, headed, "The last photograph taken of Mr. Edison."

He had on what we would call a pongee suit, although I think he spoke of it as China silk, which it probably was. He reached down, took my hand, and asked me to feel of it and said: "Did you ever see anything quite so thin?" He pulled his trousers nearly up to his knee and said: "And I haven't got anything on under it."

The late Elmer A. Sperry, who was president of the American Society of Mechanical Engineers two years ago and who took part in the fiftieth anniversary celebration to which I later refer, in recounting some anecdotes of Mr. Edison, told the following story, which illustrates the side of his character which those who knew him well were accustomed to see:

"Mr. Edgar has given us all a beautiful picture of Edison, the youth in overalls, swinging his legs from a work bench at Menlo Park. I want to draw a little picture of Mr. Edison at eighty-two.

"When he came in he spied me with a cane. He said: 'Sperry, what are you doing with that cane?' I tried to explain that it was only a habit of mine that I had recently acquired. He said: 'I have no use for a cane, now see me kick!' He jumped up out of his chair and kicked higher than his shoulder instantly.

"Of course we were all wonderfully amused and laughed. I believe I applauded. He said: 'Well, if you laugh at that, I will give you something to laugh at. I was away on one of these here vacations.' He did not speak in very respectful terms of a vacation, although I can not understand how he could resist his friend, Mr. Ford. I think he was the one who teased him into having his first vacation. He said: 'While on one of these here vacations, I kicked like that and Mr. Burbank tried to imitate me and he fell down on his back and hurt the back of his head. Ha! Ha! Ha!'

"He laughed as though he were a boy of ten. We could all see that the picture of Burbank picking himself up out of the leaves and rubbing the back of his head must have been very vivid in his mind, as he recalled it, because he laughed until the tears ran down his face and we shared in his merriment."

Mr. Edison always kept up the acquaintanceship with those whom he called his boys, and as a result of this close relationship, some of his early associates organized, in the year 1918, what they called the Edison Pioneers. Those who have been associated with Edison up to and including the year 1885 were eligible to membership. There were, perhaps, 125 to 150 who joined the association and there are remaining in this class to-day 106 members. We later broadened the organization to take in associate members, those who were connected with Mr. Edison between 1886 and 1900. This class was limited to 150. There are still living 97. We also authorized a descendant membership, consisting of the sons and daughters of either the members or the associate members. There are thirty of these.

It has been our practice to have a dinner on Edison's birthday, February 11, and we have usually had from 150 to 250 present, consisting of the members and their families. One of these dinners was in Mr. Edison's own house, one or two in one of the upper floors of his laboratory, and the remainder in either a New York or a Newark hotel. Until within the last three years Mr. Edison and his entire family have attended these reunions, and he has rubbed shoulders with those who were with him in those early days. For the last two or three years he found it necessary to go to Florida on account of his health before the cold weather set in, and the meetings had to get along without him.

It is on occasions like this that the old acquaintanceships have been renewed, not only between Edison and the boys, but between the boys themselves. For example, at a meeting of the Pioneers held in Orange the day before Edison's funeral, at which 150 were present, I met one man whom I had known intimately but had not seen for forty years. At these meetings Mr. Edison seemed to renew his youth and became really one of the boys himself. It was under these circumstances that we all came to call him "The Old Man."

There is one thing that you people will have to bear in mind in thinking of the relationship between Mr. Edison and his associates and that is his extreme deafness. For the last two or three years he had been what I should call absolutely deaf. He never learned lip reading, neither was he willing, until very recently, to try any of those mechanisms for the deaf. The result was that his conversation with his friends, with the possible exception of his own family, were quite largely carried on by writing on slips of paper.

When I went out to see him last year with The Society for Electrical Development Memorial, I had to write on a piece of paper, just how I happened to be there, and had to answer in the same way any questions which he asked me about the society. This made it not only difficult, but really embarrassing to try to carry on any conversation with him. Curiously enough, he seemed to understand his wife perfectly, but this was not in any sense lip reading, as she had to put her mouth up close to his ear when communicating with him.

This infirmity sometimes had its ludicrous side. I remember about twenty or more years ago, when a dinner was given to Lord Kelvin, Sir William Thompson, at the Waldorf in New York, Mr. and Mrs. Edison were present, and in the speech-making which took place some very complimentary remarks were made by the chairman regarding Mr. Edison. Everybody, including Mr. Edison, applauded vociferously.

His wife leaned over, pulled down his head, and whispered something to him. He immediately blushed, sank down in his chair and almost disappeared under the table. While he was very much embarrassed, he saw the joke, as did everybody else.

Mr. Edison was given the honorary degree of Ph.D. by Rutgers College quite early in life. Some ten years ago the question came up of giving him the degree of doctor of science. I happened to be on the honorary degree committee, and it developed that two or three years prior to that time he had been approached by one of our leading trustees and had turned down the suggestion with the general expression—"What's the use?" We agreed to make another attempt with considerable hesitation, but after talking the matter over with Mrs. Edison and his secretary, I put my attempts in a somewhat different way from that in which he had been approached before.

I practically said to him: "Of course you don't care anything about this degree. It doesn't mean much to you, you have so many, but I want you to look at the other side of the picture. Rutgers is located within ten miles of where you did your most noted work. You have become a Jerseyman by residence, and Rutgers is distinctly a Jersey institution. More than a dozen Rutgers men have gone into the employ of you or your associate companies upon their graduation. I happen to be one of them. I think you owe it to us and to the college to let us show our appreciation of you." This finally won him over, but even then my job was only half done. He has always had a great habit of forgetting appointments, or rather of becoming so absorbed in his work that he has neglected his appointments. I reported back to the college that he accepted, but that I would not guarantee his presence at the commencement exercises.

When he found that he had to drive over to New Brunswick he demurred again, but finally things were smoothed out and he started for the college. The academic procession was to start at eleven o'clock. At ten minutes of eleven he apparently had not arrived. I was beginning to get very much disturbed and wandered around the campus, thinking that he might have been sidetracked by some acquaintance and had forgotten where he was to meet the other delegates. I finally drifted into the robing room and there I found him, sitting in an armchair way back in the back of the building. I rushed up to him and his only comment was, "I didn't like the looks of that crowd out there, so I sneaked in the back door."

At the collation which succeeded the ceremony, Mr. Edison sat, as he always did on occasions of this kind, looking a trifle bored. He did not hear what was going on and acted as if he wished the thing were over. Finally the glee club grouped themselves around him and commenced to sing some of the college songs. You never saw such a change in a man. He kept time to the music with his feet and with his knuckles on the table and showed very clearly that he was finally thoroughly enjoying himself. As he drove away from the campus that afternoon, Mrs. Edison turned to me and said: "I am so glad we made him come. I think he has had a wonderfully good time."

The incidents which I have recited may give you a slight idea of the kind of a man he was to those who were associated with him personally.

At the annual convention of the National Electric Light Association, held in Atlantic City in the summer of 1929, a day was set aside as "Edison Day." It was, as you know, just prior to the fiftieth anniversary of the invention of the incandescent lamp. It was my good fortune to preside and I opened the meeting with an address which I called: "The Inspiration of a Name." I am not going to read it to you entirely, but there are a number of things in it which, although written before his death, are appropriate to be repeated now. These, I hope, will give you my conception of the other side of the picture. Speaking of the anniversary of the incandescent lamp, I said:

"There will be those who will stress the inestimable value of this invention and his meritorious work leading up to and succeeding its accomplishment, while others, like myself, will be more inclined to consider the character of the man himself, and discuss the individual rather than his achievements."

The pages of history are illuminated with the names of those who have attained renown through some distinguished service for the welfare of mankind. I shall classify these illustrious personages into two separate and distinct groups.

In the first group the much larger number devoted their individual efforts to a cause which was dear to the hearts of their fellow men.

Washington, the beloved Father of His Country, is a shining example of this type. He was called into service during a great national crisis which existed even before he responded to the summons. It may be said to his everlasting credit and honor that he carried out his task to a most successful conclusion. He found a struggling colony oppressed by the heel of a tyrant; he left a peaceful republic happy in its hard-earned freedom.

Lincoln, the Great Emancipator, is another outstanding example of this type of famous men. He was called to preserve a nation. He not only threw off the shackles of the oppressed, but he perpetuated a union which was threatened with disruption and disaster.

Throughout all times and in all nations of the world there have been numerous other examples of this devoted type. Many of these, as in the cases of Washington and Lincoln, dedicated themselves to the preservation and upbuilding of their country, while others were inspired to action not by love of country, but through their consecration to religion. Contrast with these others who have used their talents in an attempt to break down and destroy civilization. These are the Caesars and the Napoleons—warriors who have risen to fame as the conquerors of hostile nations, rulers who have reared vast empires to satisfy their ambition and lust for power. The former type, working for the upbuilding of some lofty principles, and the latter, disrupting the order of the world to satisfy their selfish desires, have all obtained the plaudits of the multitude. In almost every case they had been working for a cause, whether it had for its object creation, preservation or destruction.

It is most difficult to analyze the thrill and emotion with which we look back upon the achievements of these striking personalities to determine how much of it is due to their individual efforts and what part is the result of an interest in the cause which they represented. The two are so clearly associated that, unconsciously perhaps, we have lost sight of the cause and have placed the individual upon the pedestal, due to our fascination for the man himself.

The other group to which I refer includes those who have risen to fame through accomplishments which were the result of a thought or an idea originating in each inner consciousness. They were not called to preserve existing conditions, to introduce reforms, or to advance the interests of the church or state. They were pure individualists who assumed their tasks, not in response to a popular demand for a leader to accomplish some desired result, but inspired only by their own visions. They had a conviction that there was some specific object which they could accomplish, and they carried their work to a successful conclusion without outside advice or assistance.

The poets, the philosophers, the painters, the musicians and the scientists are all men of this type. They have delved into the mines of nature's mysteries and have brought to light gems of truth and beauty which have added to the wisdom and culture of the ages, and it remained for Edison to discover the source from which, at his magic touch, was created a new sun for a new world, dispelling darkness and bringing added comfort into the homes and revolutionizing the life and methods of a grateful world. For him nature revealed her hidden secrets, and through him a new industry sprang into being. After centuries of unconscious waiting, the world awoke to realize that the dark watches of the night had wasted away and a new day of light and gladness had dawned for mankind.

I shall not attempt to recount the practical results which have followed this invention. I am leaving that as a theme for others. The thought which is uppermost in my mind has to do with Edison, the individual and the friend, rather than with Edison, the inventor and the discoverer. There are many members of the Edison Pioneers still carrying on and I feel that their thoughts are running parallel with mine, and that they will agree with me when I state that we are inspired not so much by what he has done as by what he really was. Those of us who have been closely associated with him and knew him intimately have received an inspiration which, though difficult to describe, is nevertheless profound and enduring. While we have been amazed at the volume of his achievements, and spellbound by his energy and perseverance, we have been especially touched by the warmth of his affection. Though he may be acclaimed a leading scientist and inventor, though he may be pointed out as the highest type of American citizen, those of us who knew him best will ever proclaim him, above all, a staunch and faithful friend.

Always modest and of a retiring nature, he has not desired fame or honors, although his fellowmen have praised him for his integrity of character, have honored him for his achievements and loved him for his self-sacrificing regard for others. Throughout his whole life no labor was too great to be undertaken for the accomplishment of a purpose when once his mind was determined to pursue it. Truly his life was a life of service, and we of the utility industry, whose basic principle is service, find in his life and work an example which it is an honor to follow. When confronted with a problem, the solution of which taxes our utmost powers, we may be encouraged to persevere when we remember how Edison conquered the apparently unattainable by dint of hard work, untiring zeal and unlimited perseverance. While we credit Edison with a remarkable degree of genius, we have his own modest testimony that much that he had accomplished has been due to hard work and perseverance; though we lack the natural powers which he possessed, we may be inspired by his example to accomplish much in the world if we apply ourselves to the tasks which are ours with his determination and his willingness to labor. To follow is the lot of the multitude; to lead is the privilege and responsibility of the master mind who dares to stand alone, if necessary, while adhering to the principles which he believes to be sound and logical.

Edison has blazed the trail through unknown wilds, while others looked on with unbelief. His was the task to lead the way and true to his high calling, he emerged with the fruits of victory amid the plaudits of those who had been unbelievers.

In looking back to review the wonderful results which he has accomplished during his fourscore years, we are again astounded that this man of mature years, but young in mental capacity and in resourcefulness, has within very recent years taken up a new line of endeavor and, we have every reason to believe, has brought to a successful conclusion an important development in one of the leading commercial industries of our times. Apparently there has been no limit to his possibilities. When those of us who knew him intimately and were inspired by his personality shall have faded from memory, the name of Edison will still live and grow with the years, an inspiration of the sons and daughters of every tongue and every nation who see the light and render thanks to him who invented it.

There are undoubtedly many of you who are listening to me to-day who either do not appreciate or who underestimate what this means. All I can say is that I am sorry for what you have missed. While all of us engaged in the public utility business are proud of our industry and really feel and believe that it is one of the most important as well as interesting businesses in the world, I want you to realize that there are some of us, perhaps few in number, who have a deeper feeling than that felt by the greater majority. It is a feeling of pride, experienced not so much on account of what Mr. Edison himself has done as for what he has inspired us to do. I do not think that any one could have been associated with him for a generation and not be influenced, perhaps unconsciously, by the spirit which has actuated him. It is hard to put into words just how we feel. Personally, I feel like bowing my head and being thankful that my good fortune enabled me to live my life in the atmosphere he has created and under the inspiration of his name.

EDISON'S CONTRIBUTIONS TO SCIENCE AND INDUSTRY

By Dr. F. B. JEWETT

VICE-PRESIDENT OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY

To undertake, within a few weeks of his death, anything like a judicial appraisement of Thomas Alva Edison in the matter of his contributions to science and industry is to attempt the essentially impossible. Even had he been a man of lesser stature, insufficient time would have elapsed in which to develop a fair perspective of his achievements. In Edison's case a longer period than usual must ensue before we can see clearly just how his work has fitted in with that of his contemporaries and into the foundations on which subsequent structures of science and engineering and industry grounded in engineering have been built.

Despite the limitations which the undoubted greatness of Edison imposes on us at the moment, it is nevertheless fitting that a tribute to him and his work should be made at this the first meeting, following his death, of the American Association for the Advancement of Science. Clearly any tribute to the man or any appraisement of his work, if it is to be of real worth, should be by those having the right of classification among Edison's peers in his own field. In this respect I feel myself incompetent, and my sole justification for appearing before you is that I may have a right to voice an opinion of those who, while not of Edison's stature, were nevertheless his contemporaries and workers in the fields which he enriched by his contributions.

Because Edison's name has been a household word throughout the world for nearly half a century—a name to conjure with and to many that of a somewhat mythical personage against whose inquiry no doors of science were locked—one runs the distinct risk of overvaluing Edison's real achievements. On the other hand, one runs equally the risk of underrating these same achievements in endeavoring to avoid the obstacles of the first dilemma. If therefore any of you should feel at the conclusion of these remarks that I have erred in my appraisal, I trust you will appreciate the situation in which I am placed in attempting to do now, in respect to a man for whose attainments I have the highest regard, something which would best be done ten or fifteen years hence.

While the titles for Dr. Millikan's appraisement of Edison and mine are the same, we have agreed to approach the matter from different angles—he from the point of view of fundamental science, on which all engineering is founded, and I from the point of view of those practical applications of science which are peculiarly the province of the engineer.

Whatever additions to fame and recognition may have come to Edison in his more mature years, a survey of his achievements as an inventor, engineer and pioneer in industries grounded in engineering makes it clear that he did relatively little during the last forty years of his life to add luster to the fame of his earlier achievements. As a matter of fact practically all Edison's claim to the title of the greatest

American inventor grew out of his work and achievements in the decade between 1870 and 1880. One has but to look over the astounding list of his accomplishments in this ten-year period to appreciate the things which raised him to such a lofty and secure pinnacle—a pinnacle both lofty and secure not only in the estimation of his fellow Americans but in the estimation of men everywhere. In the years which followed this prolific period, and particularly in the decade between 1880 and 1890, Edison's contributions, while vast and important, were essentially different from those of the years in question. They were in the main contributions to the successful employment of his earlier work and were devoid of the brilliance of imaginative insight then so characteristically evidenced.

Nor is it surprising, when one comes to look back on Edison as he was at that period and on science and engineering as it then existed, that he should have been so enormously productive during these few years and that subsequently his life should have run in quieter waters, so far at least as concerned the making of substantial additions to the tools of engineering and industry.

Despite the fact that Edison was imbued to the highest degree with that characteristic which is the hallmark of science, namely, the characteristic of subjecting every theory to the acid test of controlled experiment, he lacked nevertheless the formal training which we normally associate with men of science and engineering. As an offset to this lack of formal training he had an intuitive insight which was unique, an insatiable curiosity and a dogged determination to overcome all obstacles. All these were associated together with a physique which permitted a punishment of the body that few men could have undertaken or stood.

In the decade of the seventies Edison was in his prime not only from the standpoint of his physical being but also from that of his creative imagination. Fortunately for him and for the world in which he lived, the development of science and engineering had during this era reached just to the point where men like Edison were required and where they could find the fullest possible play for their particular genius.

A great store of new facts in what we are now sometimes wont to consider as the grosser physics, in distinction to the more ethereal physics of our present time, had been assembled. To make these facts available for the everyday uses of society required just such an inventive genius and engineer as Edison proved himself to be. It was characteristic of Edison that he saw and seized the opportunity which was his to his own and the world's very great advantage. That the years of his life subsequently were devoid of spectacular achievements in the field of invention is not surprising. All the forces of life and society were against this. Fecundity in ideas is peculiarly the normal characteristic of man's earlier years. Further, in Edison's case—practical man that he was—the carrying out of the intricate details which were the normal fruitage of his own creations demanded a vast tax on his time and energy, which left him little of either to devote to new and untrodden fields. Also, as science itself developed, the practical application of new knowledge came to require a type of training which Edison did not possess.

That this is so, and that Edison during the last part of his life was not the same conspicuous producer of new things that he had been in his early manhood, is not in any way a detraction from his real greatness.

Coming back now more specifically to the things on which it seems to me Edison's claim to greatness is firmly grounded, we find them to be four in number. First, his work in the field of telegraphy in the very late sixties and early seventies; second, his production of the carbon telephone transmitter in 1876; third, his invention of the phonograph in 1877, and finally his development of a practical incandescent lamp and of the system of electrical generation and distribution needed to employ it practically, in 1879 and in the years immediately following.

Of the four, the invention of the phonograph is unquestionably his greatest single achievement from the standpoint of daring imagination, while his development of a practical incandescent lamp and of all the adjuncts that were required to make it commercially available, was his greatest engineering achievement. Since this last achievement marked the inception of a great industry which has carried his name to the far places of the world, it is probably the thing by which he will be longest and best known.

Outside the ranks of those in the communication field itself, the world now hardly thinks of Edison as a great contributor to the development of distant electrical communication. This is due to the fact that despite the importance of his inventions to the art of the period in which they were made, they have with the passage of time, for the most part, now passed into the oblivion of ancient things. Other developments and other applications of a science which did not exist when Edison was a young man have displaced them. The Edison quadruplex and the various other things which he devised were nevertheless marvels of ingenuity in their time and, while they lasted, greatly to the advantage of telegraphic communication and its development.

In the field of telephony Edison's work in connection with the development of a carbon telephone transmitter—that device which was needed to give a mighty forward impetus to Bell's great fundamental invention—has had a more lasting life. Carbon transmitters in one form or another are still the basic instrumentalities for translating sound vibrations into electrical vibrations. Nevertheless, Edison touched the telephone art only at a point, and except for the lasting results which grew out of this contact, he did not influence the development of this art as he did that of the electric light or phonograph arts.

In his invention of the phonograph Edison displayed an imagination, a skill and a perseverance of the very highest order. This invention alone might well have inscribed his name indestructibly in the history of America and of the world. Just as Alexander Graham Bell's name will go down through the ages as the man who made possible the instantaneous transmission, to a distance, of the human voice, so the name of Thomas Alva Edison will go down as that of the man who first made possible the preservation in time of the human voice.

At a time when phonographs, both acoustical and electrical, are an everyday commonplace, and where most of those in the world who are less than forty years of age can hardly conceive of life without the phonograph, it is difficult to appreciate the degree of daring which Edison displayed in even imagining that he could imprison such a fleeting thing as the energy of the spoken word. Equally difficult is it for the average man of to-day to conceive of the daring involved in imagining that out of the prison thus created could come, at some remotely distant time, a reproduction of ancient words, possibly those of men long dead, with the full vigor and clarity of the original speech.

With the successful completion, in the late seventies, of his long and arduous quest for a suitable filament material and its incorporation in a properly designed and evacuated glass container, Edison turned a hitherto scientific oddity into a practical and commercial light-producing instrument. The carbon filament incandescent lamp as it came from Edison's hands contained in itself enough of ingenuity, painstaking research and clear insight into fundamental requirements, both scientific and practical, to have insured him a permanent place in the history of electrical development, had he done nothing else in the field of electric illumination. For Edison the incandescent lamp was but an incident, however. In itself it was useless for the purpose he had in mind. It was merely the first link in the chain which he was to forge in creating a great new industry of immeasurable benefit to mankind. The forging of this chain was to afford Edison ample opportunity to show himself a great engineer as well as a great inventor, and was to consume a major part of his time and energy for a decade or more.

As an inventor and experimentalist he had produced an ingenious and potentially valuable illuminating device, but the electrical art of 1879 was almost entirely devoid of the things to make it commercially available. Seldom has the creator of so perfect a new tool found the field so bare. More seldom still has one done so much to create an art around and for his tool as Edison did in the ten years following 1879.

Generators, systems of distribution and utilization, switchboards, auxiliary equipment and adjunct devices, large and small, in vast profusion flowed unceasingly from Edison and the group of intelligent young men with whom he surrounded himself. In the welter of this torrent of new things no one will probably ever know just who was initially responsible for each and every one of them. Three things are certain, however: first, Edison himself was the creator of the principal items; second, his was at all times the guiding mind and the driving force; third, the group of men who later came to be known as Edison Pioneers, and who were and in large measure still are dominating factors in the electric light and power industry, were youths of his discerning selection.

No better proof of the fundamental soundness of Edison's work in those early days of electric illumination is required than the knowledge that the basic things of the art he then developed are still the basic things of the vaster art which has evolved from it. New devices and applications, many of them involving scientific knowledge which did not exist when Edison was pioneering, have been made in inventions and uses, but still in its fundamentals the art of electric illumination is the art as Edison created it.

Nor was this art merely the result of happy chance shot through by flashes of brilliant imagination. Brilliant imagination there was in plenty, but at the bottom it was the result of clear thinking, untiring labor, faith and a willingness to face facts of every description and mold them all to an ordered progress.

Only a great engineer as well as a great genius could have done the things which Edison did in the electric light and power field. That his work and his preeminence were recognized by his contemporaries is evident when we come to examine the roster of names which make up the great electric light and power companies. Many of the most brilliant stars in the galaxy of these organizations have the name "Edison" as part of their title. Had these names been chosen in recent years one might attribute the choice to some desire to capitalize the popularity and mystery which has come to be attached to Edison and his work. The fact that the names go back in most instances to the very early beginnings of the electric light and power industry, and so to a time when Edison was but little known outside of his own field, makes it clear that within that field he was even then recognized as master.

If one were writing a complete biographical appraisal of Edison and his works, pages could easily be filled with descriptions of the tremendous array of things which he produced and patented, and of the wide range of his interests. In so short a note even as the present one there is great temptation to expand the list to include a few more items, notably his work in the motion picture art. Some of this work is but little inferior to that which seems to me to constitute Edison's principal unassailable claim to fame.

The amazing variety of the things which Edison did and the fact that he seldom made contact with any art without contributing something to its advance lead one to speculate on what might have happened to the development of some of these arts had Edison concentrated his attention on them during the years of his greatest productivity.

In closing this brief appraisement of the engineering side of a man for whom I had the most sincere regard, I can not refrain from voicing a bit of regret that during his evening years his name should have been so frequently associated with inconsequential things or with personal idiosyncrasies, with which we are all amply provided. While these associations subtracted nothing from the judgment of men who knew Edison's real worth, they did unquestionably portray a great man in a somewhat false and belittling light to vast numbers of a younger generation.

EDISON AS A SCIENTIST

By Dr. ROBERT ANDREWS MILLIKAN

DIRECTOR OF THE NORMAN BRIDGE LABORATORY OF PHYSICS, CALIFORNIA INSTITUTE OF TECHNOLOGY

I AM asked to say something about the scientific qualities and achievements of Mr. Edison. But from my point of view the scientific influence of any man is so interwoven with his character, with his mode of thought, with his outlook on life as reflected in his acts, his words and his daily walk among his fellows that I prefer to let what I say about Mr. Edison's science grow out of a somewhat broader consideration of the qualities which made him the commanding figure that he was and that, as I think, he always will be.

I should like to raise first one very fundamental question. Is it merely an accident, a coincidence, that the two greatest scientists of the nineteenth century, the two who, the world over, would be first named as the most significant creators of the age of electricity with all that it has meant to the world, namely Michael Faraday and James Clerk Maxwell, were also great souls, possessors in peculiar measure of the virtues which in all times and all places have been regarded by mankind as the most fundamental, namely, modesty, simplicity, straightforwardness, objectiveness, industry, honesty, human sympathy, altruism, reverence and a keen sense of social responsibility. These qualities arise, I think, from one great all-inclusive quality, namely, balanced but penetrating and objective judgment, *i.e.*, from a correct understanding of relations between phenomena, social as well as physical, including that of one's own position in the scheme of things: and this quality, this perception is precisely what gives the great scientist his insight and his effectiveness. Smart rogues, clever scoundrels, gifted egotists, exist, no doubt; but do they do the things that live? I suspect not often. Certainly history is replete with the names of great scientists who have also been great souls—Copernicus, Leonardo da Vinci, Newton, Kepler, Faraday, Helmholtz, Pasteur, Maxwell, Kelvin, Lorentz, Einstein. What a galaxy of greatness not merely as scientists but as men!

Had Edison their quality and was this the reason of his greatness? I did not know him intimately, but I saw enough of him to be sure that I saw some of their virtues. He had not the educational background of most of them, and might therefore have been expected to be somewhat wanting in their breadth of vision, but the very exceptional minds—the really great—do not need the schools, for they appreciate what educational opportunity means, and have the capacity to become educated without the aid of the schools. This quality—the *sine qua non* for a scientist—namely, the appreciation of one's own ignorance and limitations coupled with the eternal urge to learn, and the will and power to follow that urge—I myself had the opportunity to see in Edison.

During the war when we were both engaged in Washington I spent an evening or two with him. He was then, at the age of seventy and more, reading some of the newer books that were then appearing in the field of pure science, and asking intelligent questions about them, too. His ears were gone, but there had been no crystallizing of his mind, such as occurs with some of us before we are born; with others, especially with so-called men of action, before we are forty; and with most of us, even with those who have learned to combine the art of knowing with the power of doing, by the time we are seventy. That Edison above all men retained his essential modesty, simplicity, intellectual honesty and willingness to learn, in spite of the disease to which it was his misfortune to be exposed in early life and continuously thereafter, is, I think, the best proof that we have of his real greatness. I refer of course to the disease which attacks and almost always lays low football heroes, movie stars, presidents and kings—the disease of publicity and adulation.

There seems to be no known method of inoculating human beings against that disease. Only the really great, apparently the extraordinarily great, are immune. One can set it up as a well-nigh universal law that "human nature can not stand too much corn," and but few men in our American history have had so much of it as did Edison. Did it go to his head, as it has done in the case of so many others who have been *almost* great? I could see no indication of it. The fact that his name became probably the best-known one in the United States, that commercial electrical companies from one end of the country to the other adopted it as their trademark, as a guarantee of their quality, that sycophants and exploiters swarmed about him—all this apparently left him practically untouched.

Nor was this merely the impression which he made upon me, one individual scientist. I well remember when Professor Fabry, of Paris, the head of the allied scientific mission sent to the United States by the Allied European Governments during the war, came back from a visit with Edison and said, "Simple, direct, intelligent, unspoiled—a very much greater man than I expected to find in view of the way his name has been exploited and the kind of influences with which he has been surrounded." So much for the fundamental qualities which make true greatness in a scientist.

As to his actual accomplishment in science. It is customary to make a rough-and-ready distinction between pure science and applied science, and it is indeed possible to set up definitions which bring out the difference as applied to a given time and place, but in the ultimate analysis all increase in knowledge is directed toward one single end, namely, the increase in human satisfactions. When one talks about pursuing knowledge for its own sake he is only asserting his belief that it is important to stretch the mind of man, to feed his intellect and his soul as well as his body. At one time and place, for example in time of famine, the latter, *i.e.*, the material need, may be the all-important one; at another time and place, for example, in a time in which the capacity for producing material things is superabundant, the former, *i.e.*, the spiritual need, may be a vastly more crying one. In the United States the period into which Mr. Edison was born was one which called loudly for the increase in material facilities. It was a new and a largely undeveloped country calling violently for transportation, for communications, for the means to make one man's labor produce the maximum of goods. Edison heard that call, saw that need, and bent his matchless energies and capacities to meet it. Our country through our patent laws had striven to stimulate our people in just that direction. Hence with his gifts and his background it was practically inevitable that his contributions to human progress should have found their outlet almost entirely through the patent office.

Had he been born to-day when, through the applicatoin of science, mankind in the United States can produce more food that it can eat, more clothes than it can wear, more buildings than it can occupy, I venture to estimate that he would have seen, as you and I see so clearly now, that the satisfactions that come from the stretching of the human mind, through the growth and the dissemination of knowledge, and through the giving of leisure for the acquiring of the knowledge of how to live more wholesomely, more inspiringly as a race than we live now, has pushed itself to the front as the greatest of our present human needs. New occasions have indeed taught new duties. Having fed his body, man's next great need is to feed his intellect, his heart and his soul. In a word, the relative importance of pure science and applied science in the United States has undergone a change since Edison was born and that for two reasons, first, because all applied science grows out of pure science, and if the springs that feed the river dry up presently there will be no river left; and second, because having learned how to feed and clothe the body the *art* of living, which comes from the growth and spread of knowledge, is now our greatest need. "Crescat scientia, vita excolatur"—"Let knowledge grow that life may be enriched."

Thus far I have said nothing about Mr. Edison's specific scientific accomplishment as distinct from his engineering and industrial contributions. There were, however, two of them. The so-called Edison effect was discovered in 1883 and patented in 1884. It underlies in a way the whole vacuum tube art with all that it has since been found to mean for the life of the race, but nothing came of it then because neither he nor any one at that time understood it, or had the time, or the urge so conspicuously displayed by Faraday, to stop and find out what it meant; *i.e.*, why nature worked that way. The credit for finding out goes in this case to Edison's scientific successors two decades later.

The second scientific accomplishment is enough by itself to make any man immortal, for to Edison alone belongs the credit of conceiving, and showing how mortal man may speak with his living voice directly to all the generations that follow after him. Could we to-day but hear Socrates and Marcus Aurelius and Shakespeare and Newton and Franklin and Goethe and Faraday and Maxwell, as our children and our children's children through the long ages will be able to hear their counter-parts of to-day and of all the times yet to come, would we not build another Promethean legend around that deed akin to that of stealing fire from heaven and bringing it down to men. That man has lived and worked and walked on earth with us in our generation. Thomas A. Edison is his name.

EDISON'S LABORATORY IN WAR TIME

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DR. JEWETT and Dr. Millikan have discussed the importance to science of some of Mr. Edison's inventions and investigations. My own talk will, like Mr. Edgar's, be based on a personal contact with Mr. Edison and his laboratory, and through it I wish to give additional details to the picture of Edison as a workman and as a scientist.

Immediately following the declaration of war in 1917 Mr. Edison telephoned President Hibben, of Princeton, requesting him to send to his laboratory four scientists as volunteer war workers. I went with three of my colleagues from the department of physics and remained for the months required to bring to a conclusion the problem which was set for me by Mr. Edison.

All through the war the newspapers published frequent stories of Edison's war activities and of the secrecy in which they were carried out. One story which I remember described experiments carried on in the dead of night on the top of a mountain with armed guards posted all around the base. Whether these stories are true or not I do not know, but I do know that Edison's research laboratory was actively at work and that contact with this work gave me a vivid picture of Edison and his methods.

Immediately upon meeting Mr. Edison and barely taking time to say "how do you do," he took out his pencil and began to describe a problem which had been put up to him by the Naval Consulting Board—the problem of increasing the efficiency of the driving mechanism of a torpedo so that a larger amount of explosive could be stored in it without changing its range or size. He gave me a very brief history of the development of the present torpedo, told me the conditions which an improved torpedo would have to satisfy, and told me to come back to see him when I had a solution.

In about three weeks I reported to him that I had found three fuels which seemed to offer possibilities. He disposed of these solutions in three sentences: "Fuel A can only be obtained in Germany. Fuel B has been tried but discarded because of the danger of explosions. Fuel C, which included wood alcohol, is no good because the sailors drink the d— stuff."

So I went back for another couple of weeks and returned with a fourth solution. Mr. Edison took the papers, looked over the calculations, muttering the while to himself, and then said, "When I don't understand work like this I get two men to work at it independently. If they agree, maybe it is all right; if they don't agree, I get a third man. Go up into room — and see whether you agree with a young fellow from Columbia University whom I put to work on the same problem."

On interviewing this Columbia scientist I found that we agreed entirely as to method but disagreed radically as to conclusions. Whereas I had found very few fuels possibly superior to those which the Navy was using, he had found that almost every fuel was superior. On looking over his work, however, I found that he had based all calculations on a formula for alcohol, C_{12} H_{22} O_{11}, which is sugar. In other words, he had been actually finding out what fuels would be better than sugar for driving the Navy's torpedoes. When I asked him where in the world he had got that formula for alcohol he said, "You see, I am a mathematician and not a chemist so I went to the library," and with that he showed me an ancient book on chemistry, in which C_{12} H_{22} O_{11} was actually given as the formula for alcohol.

Following this conference, Mr. Edison arranged for me a visit to one of the naval torpedo stations, where the calculations were checked by the torpedo engineer and the work was left in the hands of the Navy, with what results I do not know.

A second investigation illustrated Mr. Edison's great fertility and imagination. There had been numerous demands for the development of a supersensitive microphone for detecting enemy operations by night or under the ground or beneath the sea. According to Mr. Edison the ordinary carbon granule microphone had too high a resistance, and he wanted to try metal granules, "But," he said, "metal granules are too blamed sluggish. We must make them lighter." He so devised this scheme: First he got a large supply of hog's bristles from a local brush factory; then he plated these hog bristles with a great variety of different metals. Some of them were plated by the electrolytic process, which he used in manufacturing his phonograph records; others were plated by cathode sputtering in a vacuum; and still others by the condensation of evaporated metals. When each of these hog bristles had plated on to it a thin coat of metal, the bristles were cut up into tiny lengths, each about a hundredth of an inch long, by a microtome such as is used in cutting specimens for microscope slides. These tiny little cylinders were then placed in a bath of caustic potash, "the stuff men dissolved their murdered wives in," said Mr. Edison, which dissolved out the hog bristle and left a tiny hollow cylinder of metal, shaped like a napkin ring, and these were the metal granules which were used in place of carbon for the experimental microphones. How well they worked I do not know, since I did not see the conclusions of the test. My guess would be that they did not work as well as carbon, since scientists think that there is a peculiarity in the structure of carbon which makes it particularly effective for microphonic purposes. It was one of Mr. Edison's characteristics, however, that he would not let his own, or any one else's preconceived ideas stand in the way of making a test. This practice certainly led to many futile experiments, but it is equally true that it led to some successful discoveries which caused the scientists to revise their earlier ideas. Edison was not ignorant of what others had done, even though he often appeared to pay little attention to it. A great reader, frequently, before starting, he read everything which had been published on the subject.

Typical of another method of Mr. Edison's work were experiments on flame throwers and on submarine periscopes. The flame thrower was desired to throw a stream of liquid as far as possible. In order to get the right design of nozzle Mr. Edison instructed one of his helpers to build in his shop a whole series of nozzles with every gradation of angle, length and shape within wide limits, and to pick out the one which threw the stream the farthest.

In the case of the submarine periscope the problem was to prevent the deposit from evaporated salt water spray from rendering the periscope mirror non-reflecting. To prevent this several things were tried, one being to bathe the mirror periodically with materials of very low surface tension, which would prevent the accumulation of water in drops. For this purpose a whole series of liquids was tried and the most satisfactory one selected.

These last two war problems illustrate the method of continual search and trial which underlay much of Edison's work. Notable examples are found in his selection of elements for the Edison storage battery and in his preparation of more than 10,000 double chemical salts in the endeavor to find the most satisfactory fluorescent screen for use with x-rays.

It is a mistake, however, to think that all Edison's work was carried on by this search and trial method. Back of everything which he did or tried there was always an idea. The starting point was always the need of accomplishing some purpose, the second stage seemed to be the suggestion of various ways of accomplishing that purpose, and the final stage consisted in trying out these suggested solutions in as thorough and systematic a manner as possible in order to find the best.

Edison's success lay, I believe, equally in his handling of all three of these stages. He was uncommonly alert to opportunities for supplying a need or presenting an improvement. He was uncommonly ingenious in figuring out ways of designing apparatus to do what he wanted it to do, and he was one of the most patient and persevering men who ever lived in carrying through his ideas to the last stage of comprehensive test.

There are some who think that the day of the inventor of Mr. Edison's type has passed because of the continually greater and greater degree of specialization and scientific background which is demanded. Whether or not this is true, it is certainly true that the talents which Mr. Edison possessed are talents which will always find their outlet in creative service.

Quoting from the inscription under an Edison portrait that appeared in the *General Electric Review*:

He had the boyish fancy to create,
Invent, devise, design, and fabricate.
Sanguine and ardent, bold and fertile too,
He dreamt. Then worked—and made his dreams come true.

J. R. H.

OBITUARY

SAMUEL MATHER

SAMUEL MATHER died in Cleveland, on October 18, 1931, at the age of eighty years. Through this long span of life, Mr. Mather had devoted a large part of his energies and of his fortune to bettering the condition of mankind. In this he blended warm-hearted sympathy with sound judgment and clear vision. His innumerable benefactions extended to many humanitarian enterprises over the face of the globe. He gave freely to relieve immediate needs, but his wise understanding inclined him particularly toward the fundamental things that make for lasting results. His long service as trustee of Western Reserve University and of the Lakeside Hospital gave him the opportunity of personal insight into the benefits that mankind derives spiritually from higher education, and physically from medical science. These occupied an ever-enlarging place in his interest and to them he gave buildings, endowments and annual subscriptions with great liberality, without diminishing his helpfulness to other humanitarian activities.

As vice-president of the trustees of the university, president of the board of trustees of Lakeside Hospital and chairman of the board of trustees of the University Hospitals, he came to appreciate the benefits of the intimate cooperation of these institutions. He was a prime mover for securing the site of a medical center in the heart of the university; his personal munificence supplied the funds for the new Medical School Building; his influence determined the university policy of the Lakeside, Babies and Maternity Hospitals, and promoted their federation, together with the Rainbow Hospital, into the "University Hospitals"; his example inspired the public to the subscription of funds for the construction of the hospitals on the university site; his wise counsel guided their policy of harmonious cooperation to the day of his death. The weight of his influence was always on the side of humanity and enlightenment, and his judgment was confirmed by the results. Notwithstanding his modest, rather shy self-effacement, his power in the community of Cleveland was supreme; for he led by force of a generous example that lighted a kindred enthusiasm in others. He did not choose to guard his gifts by conditions; he investigated and gave, and the conditions took care of themselves. He trusted people, and they responded to his trust. The generous civic spirit of which Cleveland is proud is the spirit of Samuel Mather.

TORALD SOLLMANN

MEMORIALS

THE Pan-Pacific Research Institution has passed the following minute in memory of Dr. David Starr Jordan:

> It is with deepest sorrow that we, the members of the Pan-Pacific Research Institution, learn of the death at Palo Alto, on September 19, 1931, of our beloved friend and coworker, David Starr Jordan, ex-president and chancellor-emeritus of Stanford University.
>
> Dr. Jordan was one of the founders of the Pan-Pacific Research Institution, and its first president as well as the most earnest supporter of its aims and ideals. He, with the members of the Pan-Pacific Science Council, in 1925 drew up the outline of purpose of the institution and aided greatly in getting the work well under way. He believed that here in the mid-Pacific might be developed a great democracy of scientists whose influence in every field of human welfare, including both science and statecraft, as they affected not only the Pacific, but world relations, could be founded. Many of the notable inter-Pacific, if not international, conferences that have been held in Hawaii in recent years are the outgrowth of Dr. Jordan's genius and vision, by which he inspired others to take hold where he left off.
>
> While honorable chairman of the Pan-Pacific Research Institution to the time of his death, he assumed active chairmanship of the Council on Aquatic Resources when he gave invaluable service to the Council and its workers during the Pan-Pacific Fisheries Conference, the beneficial results of which compass the whole Pacific Region.
>
> In the death of David Starr Jordan our institution, as well as the entire American Commonwealth, sustains one of its greatest losses. Dr. Jordan was one of the foremost educators and scientists, as well as publicists, that America has claimed in the past generation. A leader who mingled with all the people and gave the best he had to give for more than half a century.
>
> THEO. C. ZSCHOKKE,
> E. H. BRYAN, JR.,
> F. G. KRAUSS

IN honor of the late Dr. Stephen M. Babcock, hollyhock gardens will be planted in at least forty-four different states on the grounds of the colleges of agriculture and agricultural experiment stations. The seed for these gardens was gathered this fall from Dr. Babcock's garden. Officials of the University of Göttingen, where Dr. Babcock completed his training, are planting a Babcock garden in his memory, as are the directors of Tufts College at which he spent his undergraduate days.

A PORTRAIT of the late Dr. Hiram Woods, Baltimore, was presented to the Medical and Chirurgical Faculty of Maryland, where he was for many years professor of diseases of the eye and ear, on November 17, at a meeting of the Osler Historical Society. Dr. Lewellys F. Barker made the presentation, and Dr. James M. H. Rowland, president, accepted the portrait on behalf of the medical faculty. Dr. Henry E. Sigerist, professor of the history of medicine, University of Leipzig, gave an address.

A MARBLE bust of the late Dr. Giovanni Di Cristina, professor of children's diseases at Palermo, who died in 1928, has been unveiled in the grounds of the Palermo Children's Hospital.

Nature reports that a tablet has been placed on the house in Egerton Road, Bristol, where he lived for the last twenty-six years of his life, in memory of the late Mr. W. F. Denning, the veteran amateur astronomer and observer of meteors, who died on June 9. The tablet was unveiled on Dec. 18 by Dr. H. Knox-Shaw, president of the Royal Astronomical Society, in the presence of a number of Mr. Denning's relatives and friends.

It is reported in the *Journal* of the American Medical Association that a committee has been formed that counts among its honorary members eminent anatomists and embryologists of all lands, while the executive committee is composed of Belgian scientists, presided over by Professor Leon Crisner. The committee was appointed to honor the memory of Albert Brachet, director of the Institute of Anatomy and Embryology at Brussels. It plans to establish an Albert Brachet prize to be awarded by the Academy of Sciences of Belgium, with which to reward the best research done in the domain of embryology.

RECENT DEATHS

Dr. Johan August Udden, director of the University of Texas Bureau of Economic Geology, died at his home in Austin, Texas, on January 5, aged seventy-three years. He was born in Sweden and migrating to Minnesota received his A.B. degree from Augustana College, Rock Island, Illinois, where he was professor from 1888 to 1911. He became interested in geology through the memorable work of Meek and Worthen being done at that time on the Illinois Geological Survey. He went to Texas in 1911 and has been largely instrumental in the development of the mineral wealth of the state. For his discoveries linking together systematic geology and mining he was knighted by the King of Sweden in 1911. It was on Dr. Udden's advice that the drilling which resulted in the oil fields of west Texas was begun. He also incited the exploration of the Permian of western Texas for potash. Dr. Udden has been active in scientific work throughout the country.

Dr. Burton Alexander Randall, professor emeritus of otology at the University of Pennsylvania, died on January 4, at the age of seventy-three years.

Dr. Henry L. Friedburg, professor emeritus of chemistry at the College of the City of New York and lecturer at Hunter College, died on December 29. He was eighty-six years old.

Dr. William Brian Duncan, assistant professor of electrical engineering at Stanford University, died on December 18 at the age of thirty-three years.

The death at the age of sixty-four years is announced of Dr. J. P. Lotsy, of Leiden, secretary of the International Association of Botanists.

SCIENTIFIC EVENTS

ITALIAN PROFESSORS AND THE FASCIST GOVERNMENT

A group of leading Harvard professors, headed by Dr. Roscoe Pound, dean of the Harvard Law School, has requested the Institute of Intellectual Cooperation of the League of Nations to consider ways and means by which Italian university professors may escape the obligation to take the oath of allegiance to the Fascist régime. The letter reads:

> We, professors and members of the various faculties of Harvard University in Cambridge, Massachusetts, United States of America, take the liberty of bringing to the attention of the Institute of Intellectual Cooperation the Royal Decree of the Italian Government of August 28, 1931, No. 1227.
>
> This decree imposes upon all university professors of the Kingdom of Italy—and among all state officials of the Department of Education it is applicable to university professors alone—the obligation to take an oath which implies complete adherence without reservation or discussion to a particular system of political ideas.
>
> Since political doctrines no less than all others should be the subject of discussion and revision, it seems to us that this oath involves an intellectual coercion which is incompatible with the ideals of scholars. As such, we feel that the Institute of Intellectual Cooperation among Nations can not ignore it. In no other way can the peoples of the world better promote intellectual cooperation than by extending mutual assistance to each other to secure to all scholars those conditions of freedom under which disinterested search for truth alone becomes possible.
>
> We, therefore, request the Institute of Intellectual Cooperation to consider ways and means by which the Italian university professors may best be helped to defend their intellectual liberty.

The oath required of the Italian professors is as follows:

> I swear to be faithful to the King and his royal successors and to the Fascist régime, to observe loyally the statute and other laws of the state; to exercise the teaching function and to fulfill all academic duties with the purpose of forming citizens active, bold and devoted to the fatherland and to the Fascist régime. I swear that I do not belong and will never belong to any association or party the activities of which are not in harmony with the duties of my office.

Eleven professors have refused to take this oath and have lost their university chairs.

MINERAL RESEARCH PROGRAM OF THE ILLINOIS GEOLOGICAL SURVEY

A new mineral research program has been inaugurated by the Illinois State Geological Survey, located on the campus of the University of Illinois, at Urbana.

Hitherto, the organization has concerned itself primarily with the study of the raw materials and rock substances of the state. This class of work will be continued, but the new program proposes to take advantage of the information already gathered (and that which later surveys will reveal), and extend the scope of research to cover utilization and marketing as well.

The new program proposes:

(1) To secure and make available both scientific and economic data which will nourish and promote the state's mineral industries;

(2) To investigate thoroughly the constitution and properties of all Illinois rock and mineral substances, paving the way for maximum utilization, either by improvement of present uses or discovery of new uses, or both;

(3) To bring the fundamental information to such a point that it can be used directly by industries and private individuals to exploit deposits to the fullest and most profitable extent;

(4) To make known the production and flow of minerals into and out of Illinois, the marketing opportunities, existing obstacles or limitations, and trends in the various industries.

New laboratories for the researches, with the most up-to-date equipment obtainable, were recently dedicated, the ceremonies being attended by leading mineral producers, manufacturers, business leaders, geologists and representatives of universities and scientific societies of Illinois and the middle west.

Dr. M. M. Leighton, chief of the Geological Survey, has made a number of recent staff appointments, to supplement the work of his regular geologic staff. The additions to the personnel are as follows:

Enid Townley, M.S., associate geologist and assistant to the chief
Judson R. Griffin, Ph.D., assistant geologist
Ralph E. Grim, Ph.D., petrographer
Robert J. Piersol, Ph.D., physicist
Frank H. Reed, Ph.D., chief chemist
Gilbert Thiessen, Ph.D., associate chemist
Charles F. Fryling, Ph.D., chemist
Orin W. Rees, Ph.D., associate chemist
Wm. D. Allers, B.S., chemistry assistant
John Robinson, B.S., chemistry assistant
L. D. McVicker, chemistry assistant
Carl Westerburg, chemistry assistant
Walter H. Voskuil, Ph.D., mineral economist

THE JOURNAL OF CELLULAR AND COMPARATIVE PHYSIOLOGY

AT a meeting of the Advisory Board of the Wistar Institute, held on May 19, 1931, a resolution was passed requesting that a meeting of representatives of each journal published by the Wistar Institute be held for the purpose of considering methods by which the material offered for publication in the several Wistar Institute journals might be best accommodated.

Later, on June 14, a conference of editors was held at the Morris Biological Farm of the institute, and steps were taken to suggest certain improvements in the preparation of papers for publication in the institute's journals. At the same time it was suggested that a new physiological journal be established to accommodate physiological papers which now appear in the anatomical or zoological journals.

This meeting was followed on August 12 by a meeting, held at the Marine Biological Laboratory at Woods Hole, of physiologists and others interested in the proposed new journal of physiology, and a group of physiologists was selected to organize the proposed journal, select a managing editor, and add to its number if it seemed desirable.

On October 17 and 18 the physiologists met at the Morris Biological Farm and decided upon the policy of the journal, selected a managing editor, and added to their number certain other physiologists, representing other phases of the science or other geographical regions. Dr. E. Newton Harvey, of Princeton University, was chosen managing editor. The other members of the board of editors are: W. R. Amberson, University of Tennessee; D. W. Bronk, University of Pennsylvania; M. H. Jacobs, University of Pennsylvania; R. S. Lillie, University of Chicago; E. K. Marshall, Jr., the Johns Hopkins University; G. H. Parker, Harvard University; A. C. Redfield, Harvard University; H. W. Smith, New York University, and L. Irving, University of Toronto.

The announcement of the *Journal* reads as follows:

> Owing to the increasing number of papers in the field of general and comparative physiology now published in journals not primarily devoted to this subject, it has appeared desirable to bring the material together in one publication. The proposed *Journal of Cellular and Comparative Physiology* is intended as a medium for the publication of papers which embody the results of original research of a quantitive or analytical nature in these fields, including both their physical and chemical aspects. Short preliminary notices are not desired and papers will not be accepted for simultaneous publication or which have been previously published elsewhere. While not specifically excluding any particular branch of physiology, contributors should recognize that excellent journals already exist for publication in the field of experimental and physiological zoology, dealing particularly with genetics, behavior, developmental mechanics, sex determination, and hormonal interrelationships, and also for pure mammalian functional physiology and the physical chemistry of non-living systems. Preference will be given to analyses of fundamental physiological phenomena whether the material is vertebrate or invertebrate, plant or animal.

It is recognized that prompt publication is essential, and the aim will be to issue papers within two months of acceptance. An abstract not exceeding 225 words must accompany each manuscript. These abstracts will be published immediately in the Wistar Institute Advance Abstract Sheets and appear later on the Wistar Institute Bibliographic Service Cards. Manuscripts should conform to the Wistar Institute publication standard. They should be sent to the managing editor or any associate editor. One hundred reprints of each article are furnished to the author or authors free; additional copies may be obtained according to rates which will be quoted as soon as the manuscript has been examined.

This journal will be issued on the twentieth days of February, April, June, August, October and December. A volume will contain approximately 500 pages and may be closed with any issue. The journal will be sold by the volume, not by the year.

THE NON-RESIDENT LECTURER IN CHEMISTRY AT CORNELL UNIVERSITY

THE non-resident lecturer in chemistry at Cornell University for the second term of the present academic year, February 15–June 1, will be Professor Alfred E. Stock, director of the Chemical Institute of the Technische Hochschule of Karlsruhe, Germany.

Professor Stock was born in Danzig in 1876, and received the degree of doctor of philosophy, *Magna cum Laude* from the University of Berlin in 1899. In 1898 he held the position of lecture assistant under Professor Emil Fischer at the University of Berlin, and from 1899 to 1900 he carried on investigations in the laboratory of Henri Moissan in Paris. Returning to Berlin he qualified for the position of privat-docent in 1904 and was promoted to a professorship in 1906. In 1909 he went to Breslau as professor of inorganic chemistry in the newly founded Technische Hochschule there, and was appointed director of the Institute of Inorganic Chemistry. In 1925 he was called to the University of Münster, but before entering upon the duties of that position he accepted appointment in the Kaiser Wilhelm Institute for Chemistry in Berlin-Dahlem, and became director of this institute and professor in the philosophical faculty of the University of Berlin in 1921. He resigned this position in 1926 to accept appointment as director of the Chemical Institute of the Technische Hochschule of Karlsruhe.

Professor Stock, according to our correspondent, "is one of the most versatile and gifted investigators in the field of inorganic chemistry, and his many investigations, numbering over 160, are characterized by brilliant experimental technique and convincing thoroughness." While at Cornell he will lecture upon the high-vacuum method for studying volatile substances, the chemistry of boron, the preparation and properties of beryllium, and chronic mercurial poisoning, discussing in detail the detection and determination of traces of mercury. His introductory public lecture, to be delivered on February 17 will be on "The Present State of the Natural Sciences." His regular lectures will begin on Thursday, February 18.

SCIENTIFIC NOTES AND NEWS

THE gold medal of the Royal Astronomical Society has been awarded to Dr. Robert Grant Aitken, director of the Lick Observatory, for his work on double stars.

AT a testimonial dinner given recently by the Medical Society of the City and County of Denver, a portrait of Dr. Henry Sewall, emeritus professor of medicine at the University of Colorado School of Medicine, was unveiled and formally presented to the society by Dr. Harry J. Corper. Dr. Frank W. Kenney, secretary of the board of trustees of the society, made the speech of acceptance. Dr. James R. Arneill was toastmaster.

DR. CHARLES V. CHAPIN, superintendent of health of Providence since 1884, retired from active service on January 4. The Providence Medical Association has adopted a resolution in which tribute is paid to Dr. Chapin's long and distinguished service.

THE annual meeting of the New York Academy of Medicine on January 7 was preceded by a testimonial dinner given in honor of Dr. Linsly R. Williams, director of the academy. Among those elected to fellowships in the academy were Drs. Karl Landsteiner, Phoebus A. Levene and Peter K. Olitsky, of the Rockefeller Institute, and to associate fellowships, Dr. Stanley R. Benedict, of the Cornell Medical School, and Drs. John H. Northrop, W. J. V. Osterhout and Donald D. Van Slyke, of the Rockefeller Institute.

DR. LIGHTNER WITMER, professor of psychology at the University of Pennsylvania and director of the Psychological Clinic, was the recipient of a volume entitled "Clinical Psychology—Studies in Honor of Lightner Witmer—Commemorating the Thirty-Fifth Anniversary of the Founding of First Psychological Clinic," at a special meeting on December 11 of the faculty of the college. Dr. Paul H. Musser, dean of the faculty, called upon Dr. Robert A. Brotemarkle, editor of the volume, who read the dedication page. Dr. Edwin B. Twitmyer, professor of psychology, assistant director of the clinic and chairman of the department, extended congratulations to Dr. Witmer. Dr. Josiah H. Penniman, provost in charge of research, made the commemorative address on "The Man and His Work." President Thomas S. Gates then presented the volume to Dr. Witmer.

A TESTIMONIAL dinner in honor of the seventieth birthday of Dr. Max Einhorn, known for his work in gastro-enterology, was given by the staffs of the Lenox Hill Hospital, the Post-Graduate Hospital and the members of the German Medical Society and the International Medical Club of America, at the Hotel Astor, New York City, on January 9.

DR. ELLEN CHURCHILL SEMPLE, professor of anthropogeography at Clark University from 1921 to 1928, who was awarded the Cullom gold medal of the American Geographical Society in 1913 for her work on the effect of geographical conditions upon the development of society, has presented the medal with her library to the University of Kentucky.

DR. LOUIS B. WILSON, director of the Mayo Foundation for Medical Education and Research, University of Minnesota, Rochester, was recently elected president of the Association of American Medical Colleges. At New Orleans Dr. Wilson was elected president for two years of the Society of the Sigma Xi.

AT the annual meeting of the American Anthropological Association at Andover, Massachusetts, on December 29, the following officers were elected for the year 1932: *President,* John R. Swanton; *First Vice-president,* Warren K. Moorehead; *Second Vice-president,* Wilson D. Wallis; *Secretary,* John M. Cooper; *Treasurer,* Edward W. Gifford; *Editor,* Robert H. Lowie; *Associate Editors,* Edward W. Gifford, Frank G. Speck and Frank H. H. Roberts, Jr.; *Executive Committee,* A. Irving Hallowell, H. Newell Wardle and M. W. Stirling.

DR. J. G. FITZGERALD has been appointed dean of the faculty of medicine of the University of Toronto, to succeed Dr. Alexander Primrose. Dr. E. Stanley Ryerson, professor of surgery, has become assistant dean.

DR. JAMES D. BRUCE, director of the department of post-graduate medicine at the University of Michigan, has been appointed vice-president of the university in charge of university relations.

PROFESSOR OTTO V. ADAMS, member of the civil engineering faculty, has been appointed acting dean of the engineering school of Texas Technological College. He succeeds Dean Wm. J. Miller, who has accepted a position as head of the department of electrical engineering in the University of North Carolina. Professor C. V. Bullen, of the University of Oklahoma, has been appointed head of the electrical engineering department of Texas Technological College, a position also held by Dean Miller.

THE Lukens Steel Company of Coatesville, Pennsylvania, has established at the Mellon Institute, Pittsburgh, Pennsylvania, an industrial fellowship whose purpose is the scientific investigation of processes employed in the manufacture of steel plates. Dr. Erle G. Hill, who received his professional education at the University of California, has been appointed to this fellowship. He is a specialist in iron and steel technology and was previously associate professor of metallurgy in the School of Mines of the University of Pittsburgh.

DR. A. J. KLUYVER, professor of microbiology at the Technical University of Delft, Holland, will be visiting professor at the Iowa State College from May 1 until the latter part of July, lecturing on physiology and biochemistry of bacteria.

DR. RICHARD HARDIE, professor of botany at the University at Stuttgart, has been called to Göttingen.

DR. CHARLES SINGER has become professor of the history of medicine in the University College, London, and Mr. E. F. D. Witchell, professor of mechanical engineering in the Imperial College, City and Guilds College.

SIR RICHARD GREGORY, editor of *Nature,* gave a popular lecture on January 6 on "Comets and Shooting Stars" before the twentieth annual conference of British Educational Associations held at University College, London.

DR. ERNST WALDSCHMIDT-LEITZ, of the University of Prague, will give in April the Dohme Lectures at the Johns Hopkins University.

DR. WILLEM DE SITTER, director of the Astronomical Observatory of the University of Leiden, Holland, who was invited by the University of California last September to visit the United States, has been making a lecture tour of the country which will culminate with two series of lectures to be delivered at the university, beginning on January 18. Professor de Sitter will be the first lecturer on the Charles M. and Maria Hitchcock Foundation for the year 1932. His first series, consisting of three addresses, will deal with "The Astronomical Aspects of the Theory of Relativity." His second series of three lectures, during the week of January 25, will deal with "The System of Astronomical Constants."

THE meeting of the Washington Academy of Sciences on January 12 was a joint meeting with the Geological Society of Washington. Dr. F. A. Vening Meinesz, professor of geodesy at the University of Utrecht and a member of the Netherlands Geodetic Commission, delivered an illustrated address on "Gravity Results of Submarine Expeditions in the East and West Indies and their Relation to Tectonic Phenomena."

Dr. William H. Welch, professor of the history of medicine at the Johns Hopkins University, gave a Mayo Foundation lecture at Rochester, Minnesota, on January 1 on "English Surgical Reformers of the Sixteenth Century."

Dr. Lewellys F. Barker, professor emeritus of medicine at the Johns Hopkins University School of Medicine, is giving the annual Scripps Metabolic Clinic lectures for the members of the San Diego County Medical Society on January 9, the subject being "Obesity." Dr. Barker gave a series of bedside clinics from January 7 to 9. The Scripps Clinic Lectureship Endowment makes it possible to bring a lecturer to southern California each year.

Dr. S. J. Crowe, of Baltimore, will deliver the fourth Harvey Society Lecture at the New York Academy of Medicine on Thursday, January 21. His subject will be "Investigations on the Underlying Causes of Deafness."

Professor Emil Truog, of the University of Wisconsin, will give a series of six daily lectures on soils, plant nutrition and fertilizers at the Massachusetts State College during the week of February 14 to 20.

Dr. H. D. Arnold, director of research at the Bell Telephone Laboratories, New York City, delivered on the evening of January 6 at the Lowell Institute the first of seven lectures on "The Application of Science in Electrical Communication" to be given by representatives of the Bell Telephone Company. The lectures, covering various branches of electric communication, take place on successive Tuesday and Friday evenings.

The Stanford University School of Medicine has announced a special course of popular medical lectures to celebrate the fiftieth anniversary of the lectures founded in 1881 by Dr. Levi Cooper Lane. They are given in Lane Hall on alternate Friday evenings at eight o'clock. The lectures are: January 8, "Dr. Levi Cooper Lane and the Popular Medical Lectures," Dr. Emmet Rixford, San Francisco; January 22, "Half-century of Progress in the Recognition and Treatment of Disease," Dr. George Dock, Pasadena; February 5, "Achievements in Surgery of the Past Fifty Years," Dr. Andrew Stewart Lobingier, Los Angeles; February 19, "Contribution of Experimental Biology and Medicine to the Alleviation of Human Suffering," Dr. Herbert McLean Evans, Berkeley; March 4, "Social Aspects of Child Welfare," Dr. Henry Dwight Chapin, New York City; March 18, "Fifty Years of Progress in the Prevention of Disease," Dr. Jacob Casson Geiger, San Francisco.

The Western Society of Naturalists held its fourth winter meeting at the University of California on December 21 and 22, with some fifty members and guests in attendance and twenty-four papers on the program.

The annual meeting of the American Heart Association will be held on Monday, February 1, at 4:30 P. M., at the offices of the association, in the Nelson Tower, 450 Seventh Avenue, New York City.

The International Congress of Mathematicians will meet at Zurich, Switzerland, from September 4 to 12. There will be a formal reception on the evening of September 4, and the inaugural meeting will take place on the morning of September 5. Morning sessions will be devoted to general addresses and afternoons to meetings of the sections. In the evenings there will be receptions and a concert. The congress will be followed by an excursion to the Jungfraujoch. Those from the United States and Canada expecting to attend are requested to write to Professor F. Gonseth, Ecole Polytechnique Fédérale, Zurich, Switzerland.

The thirty-fourth annual meeting of the Maryland State Horticultural Society was held at the new horticultural building of the University of Maryland, College Park, on January 4 and at the Lord Baltimore Hotel on the following day in connection with the convention of the Maryland Farm Bureau Federation. In addition to speakers who discussed problems of fruit growing, a feature of the program was the inspection and dedication of the new horticultural building at College Park. State Senator Earle W. Withgott, Easton, vice-president of the Horticultural Society, presided at the dedication and Mr. Samuel M. Shoemaker, chairman of the university board of regents, made the principal address. The horticultural building measures 186 by 98 feet and is of concrete and stone construction. The main section is of three stories, flanked by two wings of two stories. The building contains laboratories for all types of horticultural plant research, canning, fruit packing, spray machinery and spray practice. Space has been provided for later installation of controlled cold rooms, where effects of low temperature upon fruits and all types of plants can be studied. Classrooms, offices, a horticultural library, an assembly room and the laboratories of floriculture, nursery and ornamental horticulture occupy the upper floors of the building.

A new teaching museum has been opened at Rutgers University by the department of zoology of the New Jersey College for Women, a unit of the university. It occupies the Yardley Memorial Room in the zoology building, named in honor of Mrs. Margaret Tufts Yardley, first president of the New Jersey State Federation of Women's Clubs, under whose direction the money for the building was raised and given to the college. The museum is open to the public and contains about half the teaching exhibits of the department of zoology, including 225 mounted birds (New Jersey), 90 bird skins (native and exotic), skeletons of vertebrates, preserved materials, anatomical models and common invertebrates and smaller vertebrates of the state.

DISCUSSION

A POSSIBLE MEANS OF CUTTING DOWN THE MOSQUITO POPULATION

LAST July, while operating a large electric resistance heater enclosed in the fire-brick structure used for spraying quartz to form a mirror blank, Mr. A. L. Ellis called my attention to the circumstance of myriads of what seemed to be mosquitoes dead and resting on the broad-domed top surface and in crevices in the top of the furnace. This demanded an explanation, and the following is taken from a memorandum that was made:

> Mr. Ellis has called my attention to the fact that during the operation of the furnace in spraying the 60-inch quartz disk recently, great numbers of what appeared to be mosquitoes have fallen on the top of the dome which covers the furnace in which the spraying is going on. The total number of these insects which have met their deaths above this furnace seems to be many thousands; undoubtedly a great lot of them have been blown away. On collecting some of the corpses which are abundant on top of the furnace, especially in the cracks, I have tried to determine the sex of those insects, whether they are females or males. This raises another question. If the insects found are males, why do they appear at the furnace in such large numbers? There is a possible answer which may or may not be true. The electric devices near the furnace produce a fairly strong three-phase 60 cycle hum, pervading all the space around it. Can it be possible that this hum represents the hum of the female mosquito and serves an an attraction for the males which gather where the noise is prevalent? If this were the case, then we should be able to account for the vast numbers of these creatures which have come to their deaths in approaching the furnace, and furthermore, and more important, there may be pointed out some way of getting rid, to a large extent, of the mosquito population. Certainly, if the male can be drawn to a spot and cooked, then the egg-laying power of the female would be curtailed, and we shall have a great diminution in the mosquito population, provided the above reasoning is in accordance with fact and provided devices are developed to produce a three-phase 60 cycle hum where mosquitoes are bred and spread about, with means for destroying the mosquitoes which are so attracted. They may be burned, or drowned, or shocked, or cooked.
>
> ELIHU THOMSON
>
> (July 14, 1931.)

The mosquito season passed, and there are now no such insects for further experiments. Let me add that where the event in which the foregoing was based took place was at the River Works (Saugus River) of the General Electric Company at Lynn, Massachusetts. Southwest of the works is an extended area of marsh land, much of it covered with pools, either due to rains, or to overflow at high tides from the sea.

Recently, in telling of the above suppositions of mine to Professor George H. Parker, of Harvard University (Department of Zoology), he kindly confirmed my guesses by saying that only the female mosquito sings or produces its characteristic note when flying, and that the males are provided with bushy antennae projecting from the head on each side, and that these are the organs of hearing, whereby the male recognizes the presence of the female somewhere near.

Now, the three-phase 60 cycle hum of the heaters in the furnace—a sort of third harmonic to the 60 cycle rate—is to my ear an exact representation of the noise one hears as a female mosquito visits one in the night, and one endeavors to crush the annoying creature by a slap of the hand on the side of the face where the pest appears to be ready to draw blood from the victim of its attentions. The fact that the note from the furnace is individual (a single note) and that its reach must be great on account of the size of the furnace itself, the object from which it emanates, would account for the multitude of males which flew towards it from the marsh land during the period of operation of the furnace.

The insects evidently hovered for some time over the warm roof of the furnace itself, and were thus gradually desiccated and fell thereon.

Can the whole race of them be thus decimated or extinguished by proper utilization of these principles?

It is notable that, in spite of the great swarm of insects, there were no reports of bites from the men employed in the furnace house. The males do not bite. The females do so, in attempting to secure nutrition for the nourishment and development of the eggs which they proceed to lay in the stagnant pools. It is easy to organize an electro-magnetic "hummer" which, at small expense of energy, can spread over a large space the peculiar hum, and attract the males; perhaps also repelling the females. Various ways of trapping the males may be suggested, as they need not be desiccated or cooked to get rid of them.

It should be added that I was informed by Dr. Parker that some efforts at attraction of male mosquitoes by producing a musical note as near as possible to that given out by the female insect itself as a lure to a trap had been made, as he remembered, but I have no further knowledge of this effort as to its effectiveness.

ELIHU THOMSON

GENERAL ELECTRIC COMPANY,
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THE NEED FOR A NEW EXPERIMENTAL APPROACH IN IMMUNOLOGY

THIS is an age of skepticism in immunology. By degrees the top-heavy superstructure of immunological truths (?) has been crumbling under the attack of the more liberal-minded workers, who are seeking to rationalize the cult of immunology in the light of chemical investigation. With the knowledge gained in the study of the protein molecule, its antigenic properties, its property of altered specificity and the part that haptenes play in altering this specificity, as well as the possibility of synthesizing antigens that will react specifically with antisera prepared from "natural" antigens; these and other trends in the more recent investigations in this field spell the doom of the older ideas, and lead the way for the final abandonment of the ornate concepts and terms that have dominated the subject and throttled any rationalistic advance up to this time.

No better evidence need be adduced to show the error of the older concepts of this branch of science than the repeated clinical failures with therapeutic agents prepared according to the established immunological theories. Even the long-suffering clinicians have ceased to clutch at the therapeutic straws that the immunologists have from time to time cast forth on the sea of hypothesis and look askance instead at any new therapeutic agent with an immunological background. In this they have recently been joined by the literary fathers of the profession,[1] so that at present the general question is "what is wrong with immunology?"

To one who is not an immunologist, a relatively simple answer offers itself at once. It may be briefly expressed by the single word—overspecialization. From a subject that originally centered about disease processes in animals or plants it has gradually developed until now it largely ceases to consider the disease and concerns itself instead with a very intensive investigation of the disease-producing agent and its various manifestations. Thus it has ceased to be the fashion to study the disease in its entirety and to substitute instead a finer and apparently more fruitless study of the alleged agent of causation of the disease. The immensity of this potential error is appalling. What if these diseases that in the main show such clear-cut clinical manifestations as to enable the clinician to constantly classify them, should be caused by agents other than those that are now credited to them! Think of the wasted immunological endeavor of recent years, if time shows that scarlet fever as it is clinically manifest, is due not to a single strain of streptococcus, but rather as recent workers are inclined to believe, to any one of a number of strains provided beforehand with a suitable environment and therefore producing a specific type of toxin. Contrast this with the greater progress that might have been made if the investigation of this disease had been conducted along lines controlled by fundamental biological facts, the chief of which being the close interrelationship between disease producing agents and their environment. How uneasy must Sydenham, Jenner, Pasteur and Koch rest when they view our repeated attempts to replace observation and experimentation *in vivo* by methods *in vitro*! One of the greatest assumptions that over-specialization in the field of immunology has sanctioned is that the test-tube is analogous to the living host. This has been a considerable handicap to progress and has led to more wasted effort than any other single factor. Fortunately the view-point is already changing and evidence is rapidly accumulating to show what an important influence the host exerts in the fundamental biological characteristics of the invading organism in cases of infectious disease. Witness the recent work of Veblen[2] who on growing certain organisms like *Streptococcus viridans* and *Bacillus typhosus* for several generations in dilute horse serum is able to demonstrate agglutination of these organisms in high dilution with an anti-horse rabbit precipitin serum, the organisms losing at the same time their ability to agglutinate with specific bacterial agglutinating sera.

In order therefore to depart from the unbiological lines of investigation that this subject has followed in the past, it is suggested that the time seems now ripe to chart and follow another line of research; one that will above all give adequate consideration to the behavior of the host in the process of attack from the invading agent. Promise of success in the light of such an attempt is not lacking. Already there is accumulated evidence to show that the cellular aggregate that goes to make up the organs and tissues of the invaded host has something to contribute toward influencing the biological nature of the invading agent. The recent work of Laidlaw and Dunkin[3] suggests that the virus of distemper when "hybridized" with the tissue of the dog (splenic pulp) is a distinct immunological entity from the same virus hybridized with the tissue (splenic pulp) of the ferret.

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[1] Editorial in *Journal of the American Medical Association*, Vol. xciii, p. 1890.

[2] Veblen, *Soc. Exp. Bact. and Med.*, 27: 204, 1929.

[3] P. P. Laidlaw and G. W. Dunkin, *J. Comp. Path. and Therap.*, 41: 1, 1928.

In this new approach due consideration should be given to the fundamental biological laws. For example no essential difference should be recognized as existing between the rapidly growing invading organism and the equally rapid growth and development of the cells of the host during the height of invasion. Just as the bacterial agents in process of their metabolism produce certain agents injurious for the host, it is likely also that those cells of the host at the site of invasion produce metabolic products that are injurious to itself. If these bacterial products by virtue of their nature as proteins, are able to lead to the production of specific interacting substances demonstrable by certain physico-chemical phenomena, *e.g.*, agglutination and precipitation, then it might be equally true that certain toxic products of the invaded cells of the host, by virtue of their protein nature, or, as likely, by their ability to act as haptenes to the main protein radicle involved in the chemical reaction, would lead also to the production of certain specific substances interacting either with the composite antigen or with the haptene group derived from the host cells.

If this newer conception be correct, then recovery from infectious disease is due to the development of neutralizing substances to the foreign proteins in the tissues and blood of the infected individual which result not only from the invasion and growth of the bacterial invader but also from the cellular destruction in the host. Such foreign proteins from the host being antigenic for the same species is not just a hypothetical possibility, as it has already been demonstrated by Landsteiner[4] to be true in the case of homologous tissue protein (serum albumin) treated with formaldehyde, nitrous oxide and other chemical agents.

Thus it seems altogether desirable that future investigations dealing with the production of therapeutic agents in diseases of bacterial origin, should develop along lines directed at establishing conditions similar to those that govern the interaction between the invading organism and the host, such as for example the production of the essential features of the disease in lower animals, followed by the utilization of such material from the involved tissue as a composite antigen to be used in the production of antisera. It is to be hoped that future experimental evidence will show that such antisera contain readily available neutralizing substances directed at the dual toxemic products of both bacterial and tissue destruction that result in the course of these bacterial infections.

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NEW YORK, N. Y.

RUMBLING CLOUDS AND LUMINOUS CLOUDS

A BRIEF description of two rather unusual cloud phenomena which have come to my notice may be of some interest. One of these was observed from the east shore of a narrow bay of Cache Lake in Algonquin Park, Ontario, on an early morning during the latter part of July of this year. It was a chilly morning and the sky was completely overcast with clouds. My attention was attracted by a rumbling sound coming from the west, such as heralds the approach of a heavy thunder storm. As I watched, a very long, low, narrow, tenuous cloud, resembling a squall cloud, appeared above the trees on the opposite shore, moving at right angles to its length. The continuous, rumbling noise, now grown remarkably loud, seemed to come unmistakably from this cloud, whose cross-sectional diameter was only about 200 feet. The cloud passed overhead eastward and was not followed by the expected rain storm. The cloud apparently marked the meeting place of two oppositely directed currents of air that differed in temperature. It seems almost incredible, however, that so much sound could have arisen from the agitated air alone, and yet this seems to be the only plausible explanation of its origin. I steadfastly looked for small lightning flashes in the cloud and saw none, although they would have had to come in rapid succession to produce the persistent sound which was heard. The noise could not have come from the rattle of hail because the cross-section of the cloud was too small to give time for hail formation; and in any case no hail fell.

The other cloud I wish to describe was a solitary, brightly luminous, cumulus cloud which I saw on a clear summer night at Hutchinson, Minnesota, some thirty-five years ago. The cloud had a horizontal diameter of about a third of a mile and a thickness of about one fourth of that distance. It rose majestically from the eastern horizon, shone with a uniform, steady, vivid, whitish light and passed directly over the town. When the cloud was overhead a great shower of insects descended to earth covering the ground all around to the number of about 50 to 100 per square foot. These insects proved to be a species of hemiptera and were non-luminous. They had apparently been induced to take wing by the bright object in the sky. I have been at some loss to account for the luminosity of the cloud. It could not have been due to reflected light coming from a city. It might be postulated that the cloud consisted of a mass of organic vapor that was slowly oxidizing, being in fact a case of an extended will-o'-the-wisp, but for several reasons this seems to be an unlikely hypothesis. At the time the cloud was observed, it was thought to be far too late in the evening for its light to be reflected sunlight. There is a possibility that a bright moon below the horizon might have been the source of the light, although I have no recollection of having seen the moon rise later.

---

[4] Landsteiner and Jablous, *Z. Immunitat.*, 20: 618, 1914.

JOHN ZELENY

SLOANE PHYSICS LABORATORY,
YALE UNIVERSITY

ENTOPTIC COLORS

I WAS extremely interested in reading the description of the phenomenon reported by Mr. Paul E. Klopsteg, which he observed in his neon tube experiments. I have observed for some considerable time what I believe to be the same thing, only obtaining it in a different manner. I am an amateur movie enthusiast, and from time to time in setting up my projector I have had occasion to run it without any film, with the light shining against a white screen and at varying speeds. I have noticed that at a certain speed which is somewhat less than the standard speed of 16 per second there is a very decided color phenomenon present. This effect is very difficult to describe, as it appears to be a mixture of flashes of the various colors mentioned by Mr. Klopsteg. I should say also that the frequency would probably be about 10 or 12 per second.

The first time the phenomenon was observed I was undecided as to whether there was a defect in my visual apparatus, but inasmuch as it can be produced at will I came to the conclusion that it was perfectly normal. If, as Mr. Klopsteg suggests, this phenomenon offers an opportunity for some original work, the thought is suggested to serve that my observation might prove of value, inasmuch as a different method of production is used. The illumination used is the regular incandescent lamp which gives a somewhat whiter light than the ordinary incandescent bulb and has a concentrated filament, but otherwise is quite standard.

ELMER F. WAY

INDUSTRIAL LABORATORIES,
GRAND RAPIDS, MICHIGAN

THE PREVENTION OF CONVULSIONS

IN connection with an item under *Science News* entitled "Sunshine and Cod Liver Oil for the Prevention of Convulsions," which appeared in SCIENCE, March 20, 1931, I wish to draw attention to the fact that in a series of experiments conducted at University College Farm, Dublin, on calcium metabolism in the pig, convulsions appeared in a group confined on a non-vitamin D diet, to a compartment lighted through window glass. Similar groups getting vitamin D did not develop convulsions. The experiments are described in a paper published in the *Journal of the Department of Agriculture*, Dublin, Vol. 30, No. 1, from which the following abstract giving a description of a convulsive fit in the pig is taken:

> A pig suddenly developed a tremor which rapidly intensified, the animal arching its back and progressing backwards until impeded by some obstacle. In some cases the pig squealed as if suffering from intense pain and after a lapse of three to five minutes it fell prostrate to recover gradually in from seven to ten minutes after the onset of the attack.

The group of pigs which developed convulsions exhibited all the symptoms of an intensified form of rickets.

E. J. SHEEHY

ALBERT AGRICULTURAL COLLEGE,
DUBLIN, IRELAND

SOCIETIES AND MEETINGS

THE TEXAS ACADEMY OF SCIENCE

THE Texas Academy of Science held its annual meeting on November 27 and 28 at San Antonio, where it was the guest of the city and had its meetings in the Witte Memorial Museum through the kindness of Director Ellen S. Quillen. An extensive and varied program was given, which was divided into papers of like interest rather than into those representing any one of the sections of the academy. The section of the geology and its closely related sciences heard among other papers presented one on the "Silting of Lake Worth," by Dean T. U. Taylor, dean of engineering, University of Texas. Dr. E. H. Sellards, of the Bureau of Economic Geology, University of Texas, gave an account of the Texas earthquake, August 16, 1931. This is the first paper in which this earthquake, which was felt over much of Texas and adjacent states, has been reviewed. William Cunningham, of the department of chemical engineering, University of Texas, gave a full account of the sulphur industry of the Texas coast. This paper was perhaps the most enjoyed of any technical paper given at this meeting. From the standpoint of research into unknown fields the paper by Frederick A. Burt, of the Agricultural and Mechanical College of Texas, on the "Formative Processes in Certain Aluminum Bearing Concretions" was noteworthy.

The section of biological sciences introduced some new speakers, who presented papers dealing with the subject of "Teaching of Natural Sciences in the Public Schools." The most unique of these papers was the one by Dr. Don O. Baird, of State Teachers College, Huntsville, Texas, on "Birds that Go to School." Charles H. Gable and Ellen S. Quillen, of San Antonio, the authors of a series of "Nature Readers for Public Schools," presented a very interesting discussion of the "Place of Natures Study in Child Education." Dr. W. R. Horlacher and D. T. Killough discussed what may be done in improving the cotton plant in a paper entitled "Chlorophyll Deficiencies Induced in Cotton (*Gossypium hirsutum*) by Radiations." These and a number of other technical papers along the lines of biology made a full day's program.

After the annual dinner, which took place at the St. Anthony Hotel, the section of anthropological sciences gave their program. J. E. Pearce, head of the department of anthropology of the University of Texas, gave an account of the work done by his department during the past year. He told of the bringing to light or of "Finding a Civilization which Once Existed in East Texas and Hitherto Unsuspected by the Archeologists." He illustrated his talk by a large number of earthenware vessels recovered from village-sites, caches and burial places. This pottery is on a par with anything yet discovered in North America and is found in such numbers as to indicate a large population with fixed dwelling places. Another unique find was a peculiar form of arrow-heads, which are always associated with burials. So far as known, this type of arrow-head has not been observed before in the United States. Judging from the published accounts of similar work this find is the outstanding one for the past ten years. Miss Emma Gutzeit, secretary of the Museum Association of San Antonio, gave an interesting illustrated account of four expeditions sent from the museum into the Big Bend Country in search of specimens and information concerning the aboriginal inhabitants of that part of Texas. The pictures shown of pictographs and petroglyphs gave the audience some idea of the kind of records left by the civilizations which have preceded our own. Colonel M. L. Crimmins, curator of anthropology of the Witte Museum, took up the story of early West Texas and told of the migration of the Aztec people from Casa Grande, a now deserted town seventy miles southwest of El Paso, through a mountainous country of Northern Mexico and ending with the arrival of the Aztec people at the City of Mexico. His story was illustrated by copy of a chart made two centuries ago in Mexico and now preserved in Spain. He stated the Aztec people much resembled the Romans and showed how they had left their imprint on the other primitive people with whom they came in contact.

The final session was held on Saturday morning. The papers given were of a general nature. Miss Kethora Remy, of San Antonio, in a paper entitled "The Mineral Content of Honey" gave a summary of a year's investigation to ascertain if there was a relationship between the amounts of minerals contained in honey and other food value. After these papers the regular business meeting completed the program. The reports of officers and committee men showed a fine growth in membership and that the academy was in good financial condition. Ten fellows and a large number of new members were welcomed into the academy. It was ordered that a year book containing the outstanding papers presented at this meeting be printed as soon as possible and that the mimeographed monthly bulletin be continued. The officers for the ensuing year are:

Dr. H. Y. Benedict, University of Texas, *President.*

F. B. Plummer, University of Texas, *assistant to the president.*

W. E. Carter, A. and M. College, *vice-president, section 1.*

E. N. Jones, Baylor University, *vice-president, section 2.*

J. F. Sinclair, Texas College of Arts and Industries, *vice-president, section 3.*

H. B. Parks, Agricultural Experiment Stations, *secretary-treasurer.*

At the conclusion of the annual meeting the executive committee met and decided to hold the summer meeting at Austin, probably the first week in June. The time and place for the annual meeting for 1932 was not decided upon.

H. B. PARKS, *Secretary*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE SUSPENDED MIRROR SEISMOGRAPH

DURING the last year of a very interesting and somewhat unusual seismograph was developed and used by two of the graduate students under the writer's supervision. Because of the extreme simplicity and high sensitivity of the apparatus, and in view of the rapidly growing interest in seismology a brief description of the instrument may be of interest.

It consists essentially of a light mirror about 3 mm in diameter hung by means of two silk fibers in an F frame after the manner of Darwin. The frame is of brass mounted on a cast-iron platform with leveling screws. The mirror hangs in the frame as shown and its motion is traced on a photographic film, which is attached to a rotating drum in the usual manner.

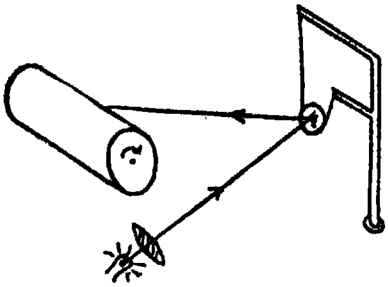

FIG. 1

This drum was made in the laboratory and is driven by a synchronous motor which was bought from one of the numerous radio-wrecking concerns.

The mirror on its support was mounted on a large brick column which was not in contact with the floor of the room. The estimated mass of this column is something like ten tons.

The apparatus has been used thus far in the study of earth tremors and disturbances of a minor nature. It detects with ease the footsteps of a person 100 yards from the building. It records the passing of a street car or an automobile half a mile away and it records (with what a physician says is fair accuracy) the heart beats of a person lying on the heavy column.

Although the apparatus is in a large empty room, remote from the walls, in a large building, it is in continual motion throughout the day. Records made when any part of the building is in use show that the ground under it is in a state of almost steady vibration.

It seems to the writer that this apparatus is particularly well adapted to the study of tremors which do not penetrate the earth very deeply. It is light, simple, inexpensive and easily portable; and it can be set up with a minimum of adjustment.

Results obtained thus far seem to justify the further use of this apparatus in the work for which it was designed.

BENJAMIN ALLEN WOOTEN
DEPARTMENT OF PHYSICS,
UNIVERSITY OF ALABAMA

APPARATUS FOR TAKING WATER SAMPLES FROM DIFFERENT LEVELS

MANY of the apparatus designed to take water samples from different levels are difficult to manipulate and, in many instances, are not accurate. This is especially true with makeshift apparatus constructed from ordinary laboratory materials. The apparatus described in this paper was used by the author in bacteriological work which required the taking, accurately, of bottom samples. Larger models of the apparatus have since been constructed and used in protozoological work with excellent results. It is easily put together with materials found in every laboratory.

The apparatus as used in bacteriology consists of a glass test-tube with the bottom cut off. This tube is fitted with two rubber stoppers which are drilled to take a piece of glass tubing an inch and a half longer than the rubber stopper. Small wire loops are fastened near each end of the test-tube and are bound in place with thread which is then shellaced or varnished. A piece of short gum rubber tubing about two inches long is slipped over each glass tube which protrudes from the rubber stopper. Other straight pieces of glass tubing with their ends bulged are pushed into

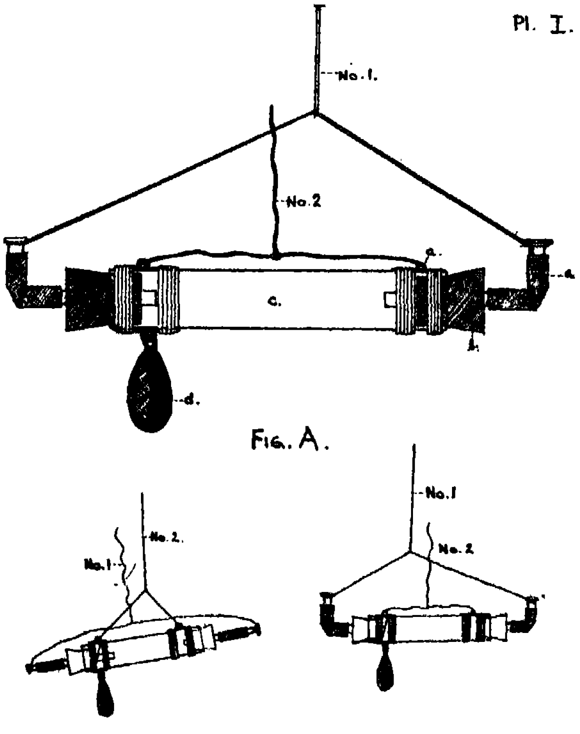

FIG. A. Detail construction: a, rubber connection acting as a valve; b, rubber stopper; c, glass body of instrument; d, lead weight; e, wire loop; No. 1, hand cord for operating the instrument valves; No. 2, hand cord for raising and lowering the apparatus. FIG. B. Apparatus with valves open and weight suspended by cord No. 2. FIG. C. Apparatus with valves closed and weight suspended by cord No. 1.

the rubber tubing, making a simple rubber joint. It is best to daub rubber cement or shellac on the glass tubing before making the connection.

A string is now tied to two of the wire loops, and another string is fastened onto the glass tubes protruding from the rubber joint. Both of these connecting strings are tied so that there is plenty of slack in them. A hand cord is attached somewhere along the length of each connecting string. The two hand cords serve to open and close the valves as well as raise and lower the entire instrument. A lead weight is suspended from the third wire loop which is fixed on the opposite side of the tube from the other loops and at one end. This weight serves to sink the apparatus as well as to slant it so that water can come in the lowest side and force the air from the higher end.

The apparatus is used in the following manner. The weight of the instrument is suspended from hand cord No. 1 (Fig. A) which is attached to the ends of the glass tubing. This action kinks the rubber connections and forms a perfectly air and water-tight valve. With the weight of the instrument supported from cord No. 1 the apparatus is lowered into the water. During this phase the No. 2 cord is paid out very loosely. When the selected depth has been reached the weight is shifted to cord No. 2 and cord No. 1 is loosened. This action allows the rubber connections to straighten out and the valve to open. When the body of the apparatus has been filled the weight is again transferred to cord No. 1, which closes the valves. With the valves closed the instrument is pulled to the surface. The rubber connections may be kept permanently closed by tying strings around the connecting pieces.

In bacteriological work a number of such instruments may be made and sterilized in the autoclave, provided the binding of the wire loops has been fixed with waterproof Valspar varnish. To remove the contents of the tube in a sterile manner the rubber valves may be cut close to the glass tubing.

Types of work other than bacteriology may require apparatus with larger openings. Apparatus have been made at this university with openings up to an inch in diameter with but a few minor changes in the shapes of the glass pieces forming the valves and the use of a double system of rubber connections.

J. Arthur Reyniers
Bacteriology Laboratories,
University of Notre Dame

SPECIAL ARTICLES

REGENERATION IN BRYOPHYLLUM

While *Bryophyllum calycinum* has been repeatedly used in physiological investigations of the phenomenon of "regeneration," a developmental and histological study of the foliar organs of this plant gives rise to a grave doubt whether in this instance regeneration really occurs. The worker is dealing with leaves possessing latent meristems in their notches which quickly form both root and shoot systems when the proper stimulus is applied. Even so able an investigator as Jacques Loeb[1] disregards entirely the presence of these foliar meristems or embryos and L. W. Sharp[2] refers to *Bryophyllum* as a case in which dedifferentiation of cells takes place in the formation of plantlets upon the leaves. A study of these problems being carried on by the writer reveals that too little attention has been paid to the anatomy and developmental history of the leaves of *Bryophyllum* and that physiological studies must take account of these facts if they are to interpret correctly the processes involved in so-called "regeneration."

The question immediately arises as to what the phenomenon of regeneration really involves. Are we to consider as regeneration only such phenomena as the reformation of a tail in the case of certain snakes, the replacement of an eye-like structure in the case of *Cambarus*, or the reformation of a growing point on the shoot axis of a plant? Or shall we include within this category the development of latent buds in the willow, of axillary buds (in many plants) which in the normal course of events never develop, and finally the development of the foliar embryos in the leaves of *Bryophyllum*? All these examples have been lumped together under the term "regeneration" by various workers and since the wide differences existing among them are obvious, the situation is a rather unhappy one.

Particularly is this the case when development of plantlets upon the leaves of *Begonia* is termed "regeneration" and the same term applied to plantlet development upon the leaves of *Bryophyllum*. Hartsema[3] has clearly shown that in the case of *Begonia* there is an actual dedifferentiation of certain cells of the epidermis and an assumption by them of meristematic characters which builds up a new plant. Work of the writer shows that in the case of *Bryophyllum* a group of meristem cells is very early segregated in the notch of the leaf even when it is 2 mm or less in length. These cells retain their meristematic character while the neighboring cells continue in the process of differentiation forming the body of the mature leaf. In actively functioning leaves 8 to 10 centimeters long this group of meristem cells may show a more or less distinct differentiation of root and shoot primordia. The writer has chosen to call these meristematic cell masses "foliar embryos" rather than "foliar buds" or "epiphyllous buds," since root and shoot develop simultaneously from them and may even be present in a primordial condition on a large, normal, attached leaf. Only a slight stimulus of the proper sort is required to cause the foliar embryos to continue their development into a new plant. Under normal cultural conditions such development does not occur on attached leaves yet it would seem that to refer to the roots and shoots produced as "adventitious buds and roots" and to include them under the term "regeneration" would be to employ vague or even incorrect terminology. A careful study of the various phenomena commonly grouped under "regeneration" makes it clear that the task of defining and limiting this term is difficult, but the writer suggests that, in cases where a preformed meristem exists which is definite and localized in position and which merely continues development due to some stimulus, the term "regeneration" is hardly applicable.

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[1] Jacques Loeb, "Regeneration," 1924.

[2] L. W. Sharp, "Introduction to Cytology," 1926.

[3] A. M. Hartsema, Extrait du Recueil des Travaux botaniques néerlandais, Vol. 23, 1926.

The existence of vegetative patches or centers upon the leaves of *Bryophyllum* is by no means a recently discovered fact for Goebel[4] refers to them, and Kerner and Oliver[5] also describe them in a superficial way. Yet few facts seem to exist concerning their structure and developmental history. Lund and Bush[6] diagram a section through the foliar embryo but otherwise make no statements regarding its structure and development except a reference to the work of Beals.[7] To the writer's knowledge this last named work is the only available histological study of the development of the plantlets upon the leaves of *Bryophyllum*. Beals draws the conclusion that certain phloem cells of the leaf assume meristematic activity and build up the tissue of the new plant. No mention was made of the dormant foliar embryo which exists even in very young leaves and which in older leaves is evident to the most casual observer. From Beals' paper it is evident that she was experimenting with fairly mature leaves.

While no attempt has been made in the present study to determine the physiological causal factors involved in the awakening of these foliar embryos it is obvious that such study must take account of their presence and structure. There is no space in the present brief note to give details of the writer's study and findings but it is hoped that they may be published *in extenso* at a later date.

JOHN A. YARBROUGH
UNIVERSITY OF OKLAHOMA

A NEW PLANT SOURCE OF VITAMIN A ACTIVITY[1]

THE recent interest in carotin and its physiological action has encouraged the examination of various plants as a source of this material. It occurred to the writers that a further investigation of the coloring matter annatto, obtained from the seeds of the plant *Bixa orellana*, might be of interest.

At least two pigments have been isolated from the seeds of this plant. Bixin, the better known of the two, has been much studied and we owe a knowledge of many of its chemical and physical properties to the researches of Marchlewski[2] in 1907.

Since that time many papers have appeared dealing with its chemical structure and properties, but Euler and Euler[3] in 1929 were apparently the first to test its physiological activity, which they reported as being negative. Palmer[4] in his monograph states that bixin does not belong to the group of carotinoid pigments, and therefore might reasonably be expected to be inactive in this respect. Palmer does not mention the less known pigment orellin, which accompanies bixin, and it is the latter material that is the basis of the present investigation.

If the crude red powder (annatto) obtained from fresh seeds of Bixa Orellana is extracted with cold 80 to 90 per cent. alcohol, a deep reddish-brown solution results, which on evaporation leaves a dark-colored, sticky, resinous material. It is in this fraction (practically bixin-free) that the vitamin A activity resides. When an alcoholic solution of this resinous material containing orellin is fed to rats on a vitamin A-free diet, at such a level that they receive 3 mg of dissolved solids per day, their rate of growth corresponds to that recommended by Sherman[5] in his quantitative estimation of this vitamin. So far as the semi-quantitative results show at present, the seeds yield 2 per cent. of this active material. This places annatto among the richest vegetable sources of vitamin A thus far reported.

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[4] K. Goebel, "Organography of Plants," I, 42, 1900.

[5] Kerner and Oliver, "Natural History of Plants," II, 40, 1903.

[6] Lund and Bush, *Plant Physiology*, 5: 491, October, 1930.

[7] C. M. Beals, *Ann.* Miss. Bot. Garden, 10: 369, 1923.

[1] From the School of Tropical Medicine of the University of Porto Rico under the auspices of Columbia University, San Juan, Porto Rico. This research was made possible by a grant from the Rockefeller Foundation.

[2] L. Marchlewski, *Biochem. Z.*, 3, 286, 1907.

[3] Beth v. Euler and Hans v. Euler, *Helv. Chem. Acta.*, 12, 278, 1929.

[4] L. S. Palmer, "Carotinoids and Related Pigments." Chem. Monograph Series, 1st ed., 22, 1922.

[5] H. C. Sherman and H. E. Munsell, *Jour. Amer. Chem. Soc.*, 47, 1639, 1925.

It is unknown at this stage of the investigation whether we are dealing with vitamin A as such, carotin or some related pigment, or a new substance which can function as vitamin A in the animal body.

A preliminary experiment of feeding bixin obtained from annatto that had had the active resinous coloring material removed by alcoholic extractions confirmed Euler's finding in that it did not cause growth in rats on an A-free diet. There is some indication that bixin may exert a toxic action on the organism.

Further work is in progress on this interesting development.

D. H. COOK
JOSEPH AXTMAYER

A NOTE ON THE EFFECT OF ULTRA-VIOLET LIGHT ON THE VITAMIN A OF BUTTER

ZILVA[1] has shown that vitamin A is destroyed by ultra-violet light when exposed in air but not in a carbon dioxide atmosphere. Spinka[2] found that ultra-violet radiations did not destroy vitamin A, but that toxic materials were formed which were sufficient to cause death in rats. His animals succumbed before the controls on a vitamin A free diet developed the typical symptoms of vitamin A deficiency.

The fact that radiations other than ultra-violet light[3] destroy the vitamin A of butter suggested that the mechanism might be of a photochemical nature.

Butter fat was exposed in large flat dishes to the rays of the quartz mercury arc at a distance of 15 cm. for 6 hours. At the end of 3 hours all the color of the material had disappeared. Another portion of the fat was exposed under similar conditions in an atmosphere of nitrogen which had previously been purified to free it from oxygen. No change in color was observed. These materials and the untreated butter fat were fed to rats depleted of their vitamin A stores, as follows: (1) The untreated butter fat; (2) butter fat exposed to ultra-violet light in air; (3) butter fat exposed to ultra-violet light in a nitrogen atmosphere; (4) the untreated material mixed in equal parts with the butter fat exposed to ultra-violet light in the air. Control animals received no source of vitamin A. The results are presented in Fig. 1.

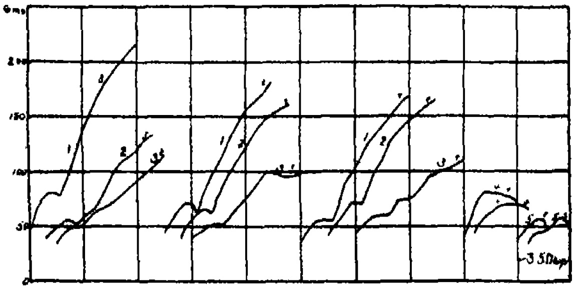

FIG. 1. Treatment. (1) 0.3 gm untreated butter fat, daily. (2) 0.3 gm butter fat irradiated in nitrogen atmosphere, daily. (3) 0.3 gm untreated butter fat plus 0.3 gm butter fat irradiated in air, daily. (4) 0.3 gm butter fat irradiated in air, daily. (5) No source of vitamin A.

RESULTS

Practically complete destruction of vitamin A potency and loss of color in butter fat was obtained when the material was exposed in air. The material exposed in a nitrogen atmosphere did not fade. Its antiophthalmic properties were not reduced in any detectable degree, although some reduction in its growth-promoting power was found.

When butter fat exposed in the air was mixed with the untreated material a definite slowing of growth was obtained as compared to that produced by untreated butter fat fed in an equivalent amount.

Negative controls and animals receiving butter fat exposed in the air succumbed at about the same time. Ophthalmia developed in both groups.

These experiments indicate that the change that takes place in vitamin A potency when butter fat fades is not due to a direct effect of ultra-violet light. Oxidation, indirectly produced by ultra-violet radiations, is at least one mode of destruction of the vitamin A of butter fat. It appears that irradiation in air and to some extent in a nitrogen atmosphere produces a principle that retards growth of rats. This principle was not of sufficient strength to cause death before the onset of vitamin A deficiency symptoms.

CHAS. L. SHREWSBURY
H. R. KRAYBILL

AGRICULTURE EXPERIMENT STATION,
PURDUE UNIVERSITY

BOOKS RECEIVED

ALEXANDER, F. MATTHIAS. *The Use of the Self.* Pp. xix + 143. Dutton. $2.00.

HOBSON, E. W. *The Theory of Spherical & Ellipsoidal Harmonics.* Pp. xi + 500. Cambridge, Macmillan. $11.50.

LOWRY, T. MARTIN. *Inorganic Chemistry.* Second edition. Pp. xv + 1101. 282 figures. Macmillan. $8.40.

NEEDHAM, JOSEPH. *Chemical Embryology.* Volume I: Pp. xxii + 613. Figures 1–104. Volume II: Pp. xvi + 614–1254. Figures 105–401. Volume III: Pp. xvi + 1255–2021. Figures 402–532. Macmillan. $35.00 for the set.

WILSON, W. *Theoretical Physics.* Volume I. Pp. x + 332. Dutton. $6.00.

WRIGHT, ALBERT H. *Life-Histories of the Frogs of Okefinokee Swamp, Georgia.* Pp. xv + 497. 65 plates. Macmillan. $8.00.

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[1] S. S. Zilva, *Biochem. Jour.*, 13: 164, 1919; 14, 740, 1920.

[2] J. Spinka, *Biochem. Ztschr.*, 153, 197, 1924.

[3] A. G. Hogan, C. L. Shrewsbury and J. F. Breckenridge, *Jour. Biol. Chem.*, 87, p. xlii, 1930.

SCIENCE

Vol. 75 FRIDAY, JANUARY 22, 1932 No. 1934

Certain Aspects of Henry's Experiments on Electromagnetic Induction: President Joseph S. Ames 87

The American Association for the Advancement of Science:
The Relationships of the Natural Sciences and the Social Sciences in Agricultural Education in the United States: Dean W. C. Coffey 92

Scientific Events:
The Importation of Scientific Specimens and Apparatus into Great Britain; The University of Porto Rico and the U. S. Department of Agriculture; To Guadalupe Island; Professorships at Yale University in Memory of Gibbs and Sumner; Award of the First Richards Gold Medal to Professor Arthur A. Noyes 97

Scientific Notes and News 99

Discussion:
Definition of a Mathematical Group: Professor G. A. Miller. *Authors' Abstracts:* Marcus I. Goldman. *The Distribution of State Agricultural Experiment Station Bulletins to Foreign Countries:* Professor J. G. Leach, Professor H. Macy and Professor C. H. Bailey. *Auditory Action Currents:* Dr. George Kreezer and Hans Darge. *Thallium Poisoning and Soil Fertility:* Professor S. C. Brooks. *Essential Fatty Acids and Goiter Producing Substances:* Professor F. E. Chidester. *The Discovery of the Oestrus Cycle in Man and Other Mammals:* Dr. Walter Landauer. *Chromosome Numbers in Ulmus:* Dr. Ruth I. Walker 102

Scientific Apparatus and Laboratory Methods:
Photomicrography with a Vest Pocket Camera: Dr. Oscar W. Richards. *A New Technique for Obtaining Oospores of the Hop Downy Mildew by Inoculating Cotyledons:* Dr. Walter Jones 107

Special Articles:
On the Variation of the Oxygen Content of Cultural Solutions: Dr. W. A. Cannon. *A Diaporthe Canker of American Elm:* Blythe G. Richmond. *A New Bacterial Disease of Pears:* Feliciano M. Clara. *The Production of Mucification of the Vaginal Epithelium of Rodents by the Oestrus Hormone:* Dr. Roland K. Meyer and Willard M. Allen 108

Science News 8

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CERTAIN ASPECTS OF HENRY'S EXPERIMENTS ON ELECTROMAGNETIC INDUCTION[1]

By President JOSEPH S. AMES

THE JOHNS HOPKINS UNIVERSITY

I REGARD it as a great honor to be invited to give the first of a series of lectures before the Washington Philosophical Society, to be known as the Joseph Henry lectures, established in honor of the founder and the first president of the society.

I think it is undoubtedly proper for me to choose as the topic of this first lecture one which is related to the life of Joseph Henry, partly because of the association of his name with the lectureship, but also because this year is recognized as the one hundredth anniversary of the discovery of the phenomena of electromagnetic induction, a discovery with which the name of Joseph Henry will always be associated.

This discovery of electromagnetic induction marked the beginning of the modern era of electricity and in fact of the modern era of physics, and it is therefore most fitting that a celebration of the centennial anniversary of the discovery should take place. Last month such a celebration was held in London at the Royal Institution, to commemorate the part Michael Faraday played in the discovery. Although he was anticipated in this by Joseph Henry, so far as both mutual induction and self-induction are concerned, Faraday will always be regarded, properly, I think, as their real discoverer because he was the first to publish the results of his investigations and pointed out at the time of his first announcement the possibility of making practical application of them. Joseph Henry, himself, although he deeply regretted the fact that he had delayed publication of his investigations, always gave full credit to Faraday and was scrupulously careful to refer to him as the discoverer. The newspapers, magazines and scientific periodicals have called attention repeatedly during the past two months to the work of Faraday and to his greatness as an experimenter and as a philosopher of nature. Rather scant notice has been given to the work of Joseph Henry, one writer saying that he "probably anticipated" Faraday; and my real reason for selecting the topic I have for this evening is my desire to impress upon all of you who listen to me the essential facts of Henry's great discoveries. Certainly whenever an American physicist hears the words, induced currents, the first thought that should come to his mind is "Joseph Henry discovered these."

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[1] An address delivered before the Philosophical Society of Washington on October 24, 1931.

It will indeed be superfluous for me to give a sketch of the life of Henry or to refer in detail to the long series of his brilliant investigations in the varied fields of physics or to his great contributions to the scientific life of this country. Any one who is interested in these matters should read the address by Professor William B. Taylor which was read before this society fifty-three years ago this month and which was published by the government in a volume devoted to the life and scientific work of Henry, and especially the excellent article by Professor Magie in the October number of *Reviews of Modern Physics*.

I intend to confine myself this evening to the question of induced electric currents and, even more narrowly, to the original experiments of Henry, calling attention particularly to the dates at which his discoveries were made. I must begin, however, by making as the background of my paper a statement concerning the scientific knowledge available at the time Henry began his experiments and also a description of Henry's environment, so that you may understand more clearly the stimulus which animated him and the difficulties under which he labored.

In 1819 Oersted made the discovery that an electric current flowing in a conductor exerted a force upon a magnet, and this great event was, of course, followed at once by investigations all over Europe. In the following year Schweigger devised his multiplier, consisting of an arrangement by which a magnetic needle came under the influence of several turns of wire, and thus perfected a rather sensitive instrument for the detection of an electric current. In this same year, 1820, Arago and Davy discovered independently that a steel needle placed axially inside a helix of wire became magnetized when an electric current was passed through the helix. In this experiment of Arago's the wire was uncovered and was wrapped in a loose helix around a glass tube, the needle being placed inside this tube. In the same year also Ampère began his brilliant series of studies on the action of currents on magnets and of currents on currents, resulting in the discovery of phenomena which form the basis of electrodynamics. In these experiments Ampère used single turns of bare wire. In 1825 William Sturgeon, of Woolwich, England, really developed the electromagnet by winding uncovered wire around an iron bar, which was insulated from the wire, the iron bar itself being bent into the shape of a horseshoe so that an armature could be placed across its two ends. In this electromagnet Sturgeon used eighteen turns, loosely coiled. These were the essential facts concerning the relations between electricity and magnetism known to the scientific world at the time Henry began his studies.

In 1826 Joseph Henry was elected professor of mathematics and of natural philosophy at the Albany Academy. This was one of the outstanding high schools of the State of New York, and the work done there compared favorably with that characteristic of some of the colleges of that day. He was twenty-seven years old at the time of his appointment, and his interests were already centered in the study of natural philosophy, his attention having been called to the subject when he was fifteen years old by the chance reading of a book which he had found left on a table by a man boarding with his mother. This book, Dr. G. Gregory's "Lectures on Experimental Philosophy, Astronomy and Chemistry," made a great impression upon the boy's mind, and it is recorded that the owner gave it to him and that he kept it with him throughout his entire life. It aroused his intellectual curiosity and inspired him with a desire to answer questions dealing with nature. He set to work at once to perfect himself for this life of investigation, and after some years of study, teaching and tutoring, during which time he presented several papers before the local scientific society, the Albany Institute, he was chosen unanimously to fill the position I have mentioned. Albany at that time was a small city practically on the frontier, remote from centers of scholarship or of study, but the Albany Academy was a very worthy institution. It occupied a large building in the center of the city, consisting of classrooms and one good-sized hall in its center, used for general purposes. There was no laboratory, of course, as such, and no apparatus of any kind; consequently, Henry had to do everything with his own hands except so far as he could call upon a blacksmith to help. Schools in those days were rather serious-minded institutions and Henry was kept fully occupied with his classes as long as the school was operating, which was for practically ten months of the year. The sessions began the first of September and during all the time Henry was professor in the academy the only opportunity he had for experimental investigations was during the summer vacations, and practically for only one month, the last part of

July and the first part of August. When the vacation began Henry would set up his apparatus in the main hall of the building and he could work with it until in August the time came for the building to be cleaned and gotten ready for the classes which met, as I have said, the first of September.

I must ask you to consider this situation and to contrast it with that of the investigators in Europe, especially of Faraday. Here was a man evidently full of ideas, evidently eager to add to knowledge and to test his theories by experiments; but he had no apparatus, he had no means to buy any even if it had been available and he had at his disposal only a few weeks of the year in which he could devote himself to what was really the purpose of his life. When one considers these circumstances it is extraordinary indeed that Henry should have been able to advance as far as he did.

Henry read with eagerness everything that was published in regard to the connection between electricity and magnetism and as soon as he became a professor at the Albany Academy he began to make plans for the continuation of the experimental work of which he had read. The first thing he planned to do, naturally, was to repeat the work of others so as to convince himself of its accuracy and to become more familiar with the phenomena. In thinking over the experiments done by others he believed that he could increase the sensitiveness of the apparatus and could magnify the forces by an extremely simple device, which apparently had not occurred to any one else. This was to use coils of insulated wire in place of single turns, and in October, 1827, he demonstrated before the Albany Institute the various experiments of Ampère and others, using coils and thus magnifying the effect greatly. In order to superimpose one layer of the coil upon another layer, thus forming a bobbin, it was obviously necessary to insulate the wire itself, which he did by wrapping the wire "with silk," as he says. I have heard from the family that "the silk" used by Henry in making some of his first coils was really a series of ribbons of silk obtained by the sacrifice on the part of his wife of her white silk petticoat. An electromagnet made by Joseph Henry and used in his experiments is still in existence, being treasured in the museum at Princeton University, and one can still see the white silk ribbons used in its construction, so I believe the story I have heard is true.

One can hardly overestimate the importance of this device of Henry's. No one up to this time had thought apparently of using insulated wire coiled in layers, and immediately after Henry described his apparatus all the investigators of Europe adopted the idea. Faraday, in his original apparatus, used when he made his discovery of electromagnetic induction, wound bare wire on an insulated iron ring, the separate coils being kept apart by winding between them a long twine, the separate layers being kept apart by pieces of non-conducting cloth. One can not tell by reading Faraday's papers whether this idea was original with him or whether it was adopted after having seen Henry's published paper. As a matter of fact, in no one of Faraday's papers is there any reference to the experimental work of Joseph Henry.

Henry's first application of this new principle of coiling long wires into a number of layers was in the construction of a small electromagnet which he exhibited before the Albany Academy in June, 1828; and, having found how successful it was, he made another more powerful one the following year, which he exhibited in March, 1829. He then had a new idea in regard to the winding of magnets and in the latter part of the same year made one in which he had two independent windings over the whole length of the iron core, so that he could join these two in parallel. Then, in order to make a magnet which could be used for many experimental purposes, in August, 1830, he wound one in a distinctly novel way, producing a magnet by far the most powerful then in existence. He wound the core of this magnet with nine separate coils, each coil occupying a space of about two inches. The terminals of each coil extended out from the side so that he was able to join the nine coils either in series or in parallel. This offered him a great variety of experimental possibilities. He investigated in connection with this magnet the effect of using a number of voltaic cells arranged in parallel or in series, and he emphasized the effect of having the cells when in series joined with the coils of his magnet also in series and similarly the effect of having either one cell or all the cells in parallel joined with the coils of his magnet when these were in parallel. He made a study of what we would to-day call Ohm's law so far as the effect of the internal resistance of batteries is concerned and also performed many other experiments, some of which I will refer to later. All this was in August, 1830. In November of the same year he saw in Brewster's *Edinborough Journal* an account of some work done by the Dutch physicist, Moll, in regard to electromagnets and thought it best to write an account of his work up to that time upon the same subject. This he did in November and submitted it for publication in *Silliman's Journal*. It was published in January, 1831, and was Henry's first scientific publication in a recognized scientific journal. It was characteristic of Henry for many years not to publish his results as soon as he had obtained them, but rather to wait until he had tested and investigated the various ideas which were in his mind on any one subject so that he would be convinced that he had exhausted the possibilities of that particular line of thought. This quality of his mind resulted naturally in the fact that so far as publication was concerned he was anticipated often, and he was in several cases persuaded by his friends to write brief accounts of what he had done after the publication by others of their work.

I refer above to experiments which Henry made with his final form of magnet, and these he did not include in his paper in *Silliman's Journal*, which was confined simply to a description of his magnets. His reason for not publishing some of these experiments, which were made in August, 1830, was because he intended to continue these further, and during August, 1831, he was very busy preparing some new apparatus, one portion of which was a large reel containing a mile of wire and another was a much more powerful electromagnet. In a letter of November 6, 1831, he says that he had been making this apparatus "for some contemplated experiments in the identity of electricity and magnetism." In another letter he says that he had to stop his work on this new apparatus because the room in which he was working was wanted for the classes of the academy. It is clear, therefore, that in August, 1831, he had been occupied with the construction of apparatus with the idea of continuing some of the work which he had begun in August, 1830, and which he had not thought to be sufficiently advanced to justify publication.

Immediately after the discovery of the fact that an electric current through a coil of wire would magnetize a piece of iron and in fact that a coil of wire carrying an electric current had magnetic properties, many investigators felt that there should be some way by which an electric current could be produced by means of a magnet, and experiments of various kinds were tried. Among others, Michael Faraday, of the Royal Institution, London, occupied himself with the problem for some years and on August 29, 1831, began a series of experiments which finally solved the problem. He reported the essential features of his experiments to the Royal Institution and also to the Royal Society, and preliminary accounts were published in the spring of 1832. Henry saw these, probably in June of that year, and thought it best to publish at once his preliminary investigations on the same subject, so that the first published account of his work appeared in the July, 1832, number of *Silliman's Journal*. In this account he describes experiments on the production of electric currents by varying the magnetic field through a coil of wire and also an observation which he had made some years before concerning the spark which is produced when an electric circuit is broken. He noted further that these two phenomena were evidently due to the same fundamental cause. I shall describe later the details of these experiments, but I wish at this time to call attention to the probable dates at which they were performed. In view of what I have said above I do not think there can be any doubt but that his observations of induced electric currents due to a varying magnetic field were carried out in August, 1830, when he was working with his new magnet. In fact, he says explicitly that the observations were made by using this magnet. When he observed the spark produced at the breaking of a circuit and studied the effect on this spark of various forms of the circuit, it is quite impossible to say. It certainly was an early observation, and the date has been set by Joseph Henry's daughter, Miss Mary Henry, as in 1829. This is extremely probable and the claim, I think, is supported by various considerations. Miss Henry says that she often talked with her father concerning the early history of electromagnetic induction and that he always spoke as if he had discovered induced currents in 1830 and made his first observations of self-induction in 1829. I think it is very reasonable to believe that it was his observation of the electric spark on breaking a circuit and certain other phenomena to which I shall refer later, these being made in August, 1829, that led him to undertake the experiments which culminated in the discovery of induced currents in August, 1830, after he had completed his new magnet. In any case he saw so much ahead of him in August, 1830, calling for the construction of new apparatus, that he thought it best not to publish his preliminary studies, so that August, 1831, found him busy making the apparatus which he felt necessary to have available to continue his investigations. Then, again, he was stopped in his work by the opening of the school session and probably he would not have published any full account of his studies until after August, 1832, if it had not been for the fact that he saw that Faraday had already made some of the discoveries with which he was familiar as the result of his own investigations.

After Henry saw the brief notes concerning Faraday's work he took up the problem anew, repeating some of Faraday's work and extending his own, although the latter was very complete and convincing.

Having made his powerful electromagnet, which I have described above (early in the summer of 1830), he wound a coil of wire around the armature of the magnet and led the terminals of the wires to an instrument for indicating current. He noticed that when he turned on the magnetizing current there was immediately a fling of the galvanoscope needle and that when he broke the magnetizing current there was a fling in the opposite direction. He further observed that when he turned the magnetizing current off and detached the armature there was also a fling of the galvanoscope needle, the amount of which varied according to the distance he moved the armature. Finally, he observed that when the armature was in place on the magnet and he varied the magnetizing current there was also a fling. So he felt justified in drawing the conclusion that there was an instantaneous current in one or the other direction in a helix of copper wire surrounding a piece of soft iron accompanying every change in the magnetic intensity of the iron. No statement concerning the production of induced electric currents could be any clearer than this.

His observation of certain phenomena of self-induction, probably made in 1829, was equally important. Having noticed this fact of the appearance of a spark which may have been and probably was a chance observation, owing to some break in an electric circuit, he studied the effect of having the circuit consist of a short wire or a long one and also the effect of coiling a conductor into a spiral or helix, noting the increased effect when the latter was done.

We have seen that in the summer of 1831 Henry was busy making a new magnet and new apparatus for experimental purposes. In 1832 he was elected professor of natural philosophy at the College of New Jersey, now Princeton, and he moved there with his family in November of that year. The first few years of his incumbency were occupied with the immediate duties of his chair and he did not have an opportunity to continue his studies until 1834. In November of that year Faraday published an account of his discovery of the phenomena of self-induction, and Henry's friends persuaded him that it was his duty to publish at once an account of what he had done on the same subject up to that time. This he did. He gave a verbal account of his work before the American Philosophical Society in Philadelphia at its meeting of January 16, 1835, and wrote a fuller account, which was published in *Silliman's Journal*. He had extended the observations to which I have referred above by investigating not alone the spark produced on breaking the circuit, but also the currents and the shock which accompanied the break. He had also studied the effect of introducing iron into a helix and had really made great progress. From this time on Henry worked fairly continuously and, apparently having learned his lesson in regard to publication, communicated his results as soon as he was convinced that they were definite. He had been elected a member of the American Philosophical Society in 1834 and hereafter he communicated his results to this society and they were published in its *Transactions* or *Proceedings*.

He continued for some years his study of the phenomena of self-induction and other effects of electromagnetic induction; in fact, there was a constant series of publications on the subject till his election as Secretary of the Smithsonian Institution in December, 1846.

In one series of experiments he investigated the effect of a discharge of a Leyden jar through his primary coil in producing induced currents in neighboring conductors and was ultimately led to the proof that such a discharge was oscillatory. (Conviction that this was the character of the discharge had been expressed previously in 1827, by Savaray, but this fact was not known by Henry.) He was able to prove also that this inductive action produced by discharges through a primary conductor was felt at considerable distances, certainly as far as two hundred feet. This is the first experiment on record of electromagnetic waves (in 1842).

One of his most important studies dealt with the effect of introducing sheets of conductors between his primary and secondary coils (in 1838). One of the main interests in this study lies in the fact that Henry's observations were quite contrary to those announced by Faraday. Henry showed that the introduction of a plate of copper cut off completely the inductive action, whereas Faraday had found that there was no shielding effect. The explanation of the discrepancy, which Henry, himself, was able to make, lies in the fact that Henry's observations were on what we nowadays call electromotive force, whereas Faraday in his investigations was concerned with the quantity of induced current. This fact emphasizes the difference in the experimental equipment of the two investigators. Henry had practically no measuring apparatus and had to content himself with such observations as sparks and the shocks received when discharges were passed through his body; Faraday, on the other hand, had a well-equipped laboratory. It is extremely interesting as one reads the papers by the two great physicists to see how they express themselves without having the benefit of the knowledge which came when Ohm's law was known. I think of the two men Henry had perhaps a clearer understanding of the essential features of induced currents, but I could not give conclusive proof of this. Both men were aware of the fact that there was one quality of the current which depended upon the rate at which the magnetic field is changed, this being what determines the shock in the muscles and the distance at which a spark will occur in a broken circuit, and that there was another property of the current depending upon the total change in the field, which determined the fling of the galvanometer needle. The former was independent of the material of the conductor, while the latter varied with it. It was not, however, until the work of Lenz and of Neumann that all the difficulties were removed and all the phenomena expressed in one simple equation.

One interesting experiment of Henry's in this connection was to show that although there were differences in the shock produced in the secondary coil when the current was made or broken in the primary, there was no difference at all in the fling of the galvanometer needle. This observation led him to a very careful study of the phenomena associated with making and breaking a circuit.

The discrepancies between the observations of Henry and of Faraday, depending upon the fact that the former was observing as a rule electromotive force, while the latter was measuring the quantity of current, reminds one very much of the discrepancies which existed in the early history of mechanics, discrepancies which were only cleared up by the mathematical work of D'Alembert. Mechanics had its origin, as is known to you all, in the work of Galileo, Newton and Huyghens, and in the century that followed their first publications a controversy arose as to the proper measure of those agencies in nature which produce the changes in velocity of a body. One school of writers insisted that the proper measure of the effect of such agencies was to be found in the difference in the squares of the velocities of the body at the beginning and the end of the action. Another school insisted vehemently that the effect should be measured by the difference in the velocity. If this dispute were stated in modern language it would be somewhat as follows: Is the effect to be measured by the change in the kinetic energy or by the change in the momentum? It was D'Alembert who first showed that neither one of them was the proper measure, because the change in the kinetic energy is equal to the product of the force by the distance through which the body moves under the action of the force, while the change in the momentum is equal to the product of the force by the time during which the body is under the action of the force. Or, it may be said, if one wishes to, that both schools were right and that they were looking at the two sides of the shield as in the ancient fable. Something of the same kind may be said in regard to the work of Henry and Faraday. Their research work was absolutely trustworthy, but their interpretation of this could not be completely satisfactory until the work of Ohm was appreciated and until the mathematicians had completed their study.

I can add but little to what is well known concerning Henry's qualities as an investigator and administrator. As one reads the various papers contributed to the memorial volume devoted to his life, one is struck by the universal admiration for his broad philosophy, his accuracy of observation, his brilliant intuitions and his devotion to the cause of science in its widest interpretation. He was unselfish to a marked degree. He was not interested the faintest in personal advancement or in advancing claims for discoveries or inventions. His sole purposes in life were to interpret nature and to diffuse knowledge among men. Beyond any doubt he is the outstanding figure in the history of the scientific life of America.

THE RELATIONSHIPS OF THE NATURAL SCIENCES AND THE SOCIAL SCIENCES IN AGRICULTURAL EDUCATION IN THE UNITED STATES[1]

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IN this country the program of agricultural education, as it relates to both teaching and research, centers in the natural and social sciences. It is perhaps safer and wiser to describe the functions of these sciences in this program in rather broad and general terms, as no two persons would likely fully agree on any exhaustive statement about either of them.

Natural science, in its application to agricultural and pastural products intended for consumption, has to do with improving and increasing production by reducing the amount of time or effort necessary to produce a unit of product and by making more resources for production available. It is addressed to the soil for such purposes as increasing balancing and maintaining its plant food elements, controlling its moisture content and improving its condition with respect to tillage. It is applied to plant life as it relates to agriculture and deals with the breeding and selection of plants and their adaptation to given conditions and needs. It has to do with their culture and with means of protecting them from the ravages of disease and insect pests. Along practically the same lines it deals with animal life in agriculture. And it also has to do with the interrelationships of soil and plants and animals.

Social science deals with human wants and primarily those which are satisfied only by associated or group action. Hence we often think of it as a science that deals with society as a whole. In agriculture we restrict its application, in large part, to that portion of society known as the rural population. The social science subjects most emphasized in agricultural education are economics and sociology, but it should be borne in mind that such subjects as history, government and politics belong in this field. It is well, too, not to overlook the fact that a considerable amount of the subject-matter in agricultural economics is directed to individual rather than to group wants. Reference is here made to teaching and research aimed at such matters as adjustments on the individual farm for the purpose of increasing individual efficiency and advantage. While there is a sharp division between individual and group wants at some points, they merge at others; therefore we can not confine the application of social science solely to group wants, but when the objective is an individual rather than a group want, the results sought are very similar to, if not identical to, the results desired when natural science is the agency used.

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[1] Address of the retiring vice-president and chairman of Section O—Agriculture, American Association for the Advancement of Science, New Orleans, December 29, 1931.

Social science is concerned with problems of distribution of wealth and income. It has to deal with questions of credit finance and taxation. Price is an organizer of economic activity and a factor in distribution and it becomes a function for a subject like agricultural economics to consider price factors and movements as they relate to agricultural products.

It is a function of a subject like rural sociology, through a technique all its own, to give attention to the improvement of human factors in agriculture to the end that there shall be a sound development of rural social policy. Attention must be given to these human factors if the improvement of agriculture itself is not to be defeated. "The capacity of the rank and file of farmers to receive instruction can be stimulated and greatly increased through processes of socialization of families, groups and communities so as to effect a nicer adjustment of individuals to a larger and more complex organization of life."[2] Dean C. B. Hutchison, of the College of Agriculture, University of California, recently gave in broad and general terms the following as the function of social science research as it applies to agriculture.[3] "It relates to the balancing of production and consumption, the ways and means of making adjustments and changes, and the distribution of the benefits from scientific progress among the members of society."

Agricultural institutions for teaching and research are more at home with subjects in natural science than with those in social science, the reason being that the national system of agricultural education was developed by placing emphasis primarily on the natural sciences. There was a logical basis for this method of development. The need for harnessing and overcoming the forces of nature was much more obvious to the farmer and even to the educator than were needs along social lines. The farmer was often squarely confronted by the limitations of cold, drouth, disease, pests, low producing powers of plants and animals, etc. As to these needs he had no trouble in expressing himself, whereas he was more or less inarticulate regarding his social needs because he could not clearly comprehend them. Moreover, a number of the present rural social problems did not develop in acute form until the system of agricultural teaching and research had become well established.

When the agricultural colleges were provided for by the federal government through the Morrill Act of 1862, a large percentage of American farmers were operating on a self-sufficient basis in considerable degree and continued so to do until well up toward the close of the past century. During most of this period rural standards of living were, in large part, determined by the capacity to be self-sufficient. The farmer's attitude was extremely individualistic. The family then enjoying a high standard of living was the large family that produced crops successfully, converted a portion of them efficiently into family needs, sold enough to pay for comparatively light overhead costs, saved a little money for investment in more land and managed to satisfy social and educational wants within the home and the closely circumscribed community.

We had of course developed the production of staple crops far in excess of the consumption needs of the agricultural population before the close of the past century. We had passed through periods of discouragingly low prices, but even so production remained the paramount idea in agriculture. With our own population growing so rapidly, we looked forward to great increases in population at home and abroad. We were impressed by the theory of Malthus concerning population, and hence felt that the only check to increases in population would result from restrictions in food, clothing and shelter. We visioned the hungry maws of England, Germany and other European countries clamoring for more food and as we turned the century the public mind entertained a fear of being unable to produce enough to feed the oncoming millions. There were those amongst the intelligentsia in agricultural education who saw the time only shortly ahead here in expansive America when we would have to limit our consumption of meat materially in order to have enough food from our available acres to feed our own people.

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[2] From monograph, "Rural Sociological Research in the United States," 1927.

[3] From paper read before the section of experiment stations, annual meeting of Association of Land Grant Colleges and Universities, Chicago, Illinois, November, 1931.

In sum, our whole agricultural philosophy was faced toward production and we were so occupied with the problems surrounding production that we pretty largely allowed social and economic problems to take care of themselves. Some of us may have thought that if we could adequately discover ways and means of overcoming controllable handicaps to production, we would solve our rural social and economic problems. For the natural science worker in agriculture almost invariably had social and economic values in mind as he has applied himself to his tasks. It was not a matter of entirely overlooking these values, but rather a matter of opinion as to how they might be realized.

While extensive consideration of social and economic problems is a comparatively recent development in agricultural education it would be hardly true to say that the problems themselves are of recent development. But much has transpired since the beginning of the present century to bring them to the fore with greatly added emphasis, and doubtless some new problems have developed. They now stand out so prominently that it would be quite impossible to deny them large consideration in any intelligent program of education.

Many things have happened to bring the economic and social problems of agriculture to the fore, but of them all two seem to be more significant than any of the others. One is the stupendous augmentation of machine economy which has occurred during the past two decades; the other is the spread of birth control. The first has greatly increased the producing power of the individual farmer and has extended crop areas by utilizing types of land which probably could not have been cropped economically without power machinery operating on an extensive scale. Then, too, the acceleration of the machine economy throughout all groups of society has had a most noticeable effect on the habits of the people, and by encouraging a more sedentary type of living has reduced the per capita consumption of food and has had an effect on the types of food preferred.

Although the machine age has been on the way for many years, what has been referred to as the new machine age ushered in at about the time the world war opened was not foreseen in its gigantic proportions and far-reaching consequences. Apparently none of us could foresee the extent to which human hands and backs would be replaced by labor-saving machinery. None of us could foresee that within a decade 30,000,000 acres of agricultural land would have to be devoted to some new use because of the decimation of the horse population. Nor could we foresee that while this would be happening the total amount of land under cultivation would be materially increased, all of which would be brought about by the greater adaptation of mechanic power and machines to farm practices.

It was no easier to foresee the movement toward birth control than the sudden upsurge of the machine economy. Either as a national or world-wide movement it was entirely outside of our thinking. In the November, 1931, *Forum*, Louis I. Dublin says: "In years preceding 1880, the birth rate in most countries was 35 to 40 per each 1,000 population. This figure is not very far from the upper limit of human reproductive capacity in a normally organized population. To-day with a very few important exceptions, as in Russia and Italy, the rates vary from 15 to 20 per thousand." Dublin goes on to say that evidence points to the conscious control of propagation through contraceptive methods as the new element which has altered the situation with respect to birth rate. He further says, "The outlook for the future is a wider application of these methods and toward their dissemination to all peoples. Whether we like it or not we look forward to much lower birth rates in all parts of the world." It therefore seems necessary to reverse the way we thought about population during the boom days of agricultural education in the first decade of the century. Again, Dublin says: "We of the United States are evidently not destined to become the great reservoir of humanity where liberty and prosperity are to reside side by side. Instead, we shall, from now on, accustom ourselves to hear questions like these. How long will America continue to increase in numbers; what will its maximum population be; how rapidly will the population decline once it begins to fall; what effect will this decline have on age distribution and therefore upon business and employment conditions; how will it affect America's position of leadership abroad? In short, now that one frontier has completely disappeared a new era of the history of the nation has set in."

We are all aware, of course, of the fundamental cause underlying birth control, namely, that with our changing modes of life there are other things more desirable than the expensive luxury of a large family. Even on the farm children are no longer an economic asset, but rather an economic liability of considerable magnitude. In consideration of the way in which we are headed there is small probability of their becoming an economic asset. Therefore, Dublin is probably correct in his views about declining birth rates.

What has happened and is happening with respect to machine economy and birth control clearly shows that we can no longer count on increase of population to take care of increases in agricultural production which may be brought about by the agencies within the field of natural science. The massive forces of the machine economy alone are too powerful for any possible rate of population increase to cope with our power to expand production, to say nothing of the fact that the rate is declining. It is clear that, from now on, the matter of balance between the production and the consumption of agricultural products will be of vital importance. In many respects it will be a delicate balance and any onrushing movement to increase production, as has been the case in the greater application of machine power, will cause serious maladjustments. From now on rural people must keep their eyes upon both the production and the disposal of their products. Already some of them have called attention to their conviction that our agricultural institutions are emphasizing production to the neglect of distribution. They have gone so far as to assert that we might very well take a holiday on matters pertaining to production in order that we may catch up with our information on distribution. In this they are wrong because much of the work in natural science is not directed toward larger production and they are unaware of the complaint that would be made were we to follow their suggestion. But their criticism carries significance, nevertheless, for it indicates their realization of how impossible it is for us to continue with an unbridled policy of production. Consequently, the long-established natural science forces in agricultural education should seek and welcome the development of social science as it may be applied to agriculture.

If we are to secure the full benefits of natural science teaching and research, under present conditions in agriculture, we must have a sound and adequate development of social science. It is the science upon which we must rely for finding the ways and means of making adjustments, of balancing production to the needs and desires of the people. Unless these things are done, natural science teaching and research will be greatly weakened as potent influences in rural life. If they are done, if production is expanded only as fast as there is need for it, then the gains or benefits from natural science can be turned into better living rather than in surplus production.

We should not conclude that study and research in social science alone will not improve conditions. Any such contention is futile. The sources of wealth are to be found in goods and services. The farmer's source of wealth lies in goods which he produces, hence he must maintain an active interest in production. In its productive phases agriculture is a biological industry and hence as subject to change and variation as the biological forces themselves. The natural science worker in agriculture need have no fear of ever being out of a job, for his services will always be in demand. He will continue to be called upon to make discoveries and to work out their applications. It will remain for social science to lead in determining where, how and how rapidly they shall be applied. So for best results, in fact for safe results, it becomes apparent that a knowledge of natural science must dovetail with a knowledge of social science. In turn each becomes the handmaiden of the other.

We would agree, I think, that the more intelligent American farmers have come to appreciate the value of natural science research as it applies to their individual businesses. In order that social science may pull itself up to the level of the accomplishments of natural science, it must engage in rather large-scale social and economic experiments which involve individuals who are acquainted with what is being attempted and who are willing to subject themselves to experimentation. Reference is made to some of the large experiments in cooperative marketing and to new ventures in land policy such as the state of New York is undertaking by acquiring abandoned farm land adjudged to be unfit for agriculture. One object in the acquisition of these lands is to prevent the waste of human effort and capital on land wholly unsuited to farming. Another is to effect savings in expenditures for schools, roads and local government. The time has come when we can scarcely avoid experiments of this sort, although it is doubtful if we should attempt to be as ambitious as Italy or Russia along these lines. The confidence that has been built up in research through natural science will help to pave the way for confidence in researches of this sort. This does not indicate a relationship between the sciences but rather a service one has rendered the other.

Attention has been called to the fact that natural science workers in agriculture have almost invariably had social and economic values in mind. There is, of course, a social reason for encouraging greater production. But aside from this, the worker in horticulture who deals with fruit and vegetable growing or the growing of ornamental plants may have little notion of boosting the total production in agriculture, but rather the hope that he may make some contribution to the satisfaction of living. The agricultural engineer, who clears the way for farm electrification, may talk all the while about how electricity on the farm can make for the efficiency of production, while deep down in his heart he may be hoping to make farm life more cheerful, happy and satisfying. We must bear in mind, too, that unless we run to seed on the subject, there is a social satisfaction in attaining efficiency in production. Many a man has spent his life in producing superior purebred live stock, fully realizing that he might have made a little more money by producing for the open market.

Many a man has lost a little money by adding increments of labor to his enterprise purely for the sake of doing the job well. Many a man has been carried on through hours of discouragement in agriculture by his knowledge of his ability to perform creditably in the processes of production. So, after all, there are no hard-and-fast lines between the two fields of science. To attempt to draw such lines would hamper both natural and social science effort.

It has frequently been difficult for natural science workers to see an important place for social science in the scheme of agricultural teaching and research.[4] In other words, they have not had a genuine respect for it as a science. Since social science is of later development than natural science in agricultural education, particularly, there was a lag in the refinement of its technique. Then, too, the complex interrelationships of social and economic phenomena are hard to understand and measure. Only in recent years have we come to feel that scientific research can be applied to these phenomena. Descriptive studies have been under way for a long time, and "qualitative analyses of cause and effect relationships based on assumptions, mainly because data were not available, have been made for more than one hundred years." Through their determination to discover principles and to secure reliable measurements of relationships the workers in social science are winning the respect of the natural scientists. Nothing else could do quite so much toward bringing about the kind of cooperation needed between the workers of the two fields.

Healthy cooperation between natural and social science can be fostered by placing adequate emphasis on the social sciences in the agricultural curriculum. Students should not be graduated without some basic knowledge of social and economic principles any more than they should be graduated without basic knowledge of the fundamental principles of natural science and particularly the biological sciences. This can be accomplished without lessening the emphasis given to natural science—in fact it is being done to a limited extent by giving less time to courses that are nothing more than "glorified practicums." Such courses are not without value, but their prominence must wane in any sound program of agricultural education. It has long since been demonstrated that the acquirement of a number of practical skills in college does not produce a finished farmer, much less a capable leader in agricultural thought.

Nor have we met the situation when we train technical farmers and technical research workers who perhaps receive no more than one or two elementary courses in economics which so often give the impression that society is governed by immutable laws and, therefore, nothing can be done about it. More training in social science than this is needed and it should be the kind of training which demonstrates that the laws governing society are no more rigid than the laws governing the forces of nature, and that an understanding of these laws can contribute to social progress quite as much as an understanding of natural laws can contribute to technical progress.

The natural science worker has implicit faith in his task. In this he is fully justified, for he has to his credit a great record of achievement. He has worked untiringly and in most cases in the spirit of altruism, or at least not in the spirit of selfishness. The world has acclaimed him and has increasingly accepted his leadership. We increasingly speak of the gains the scientific temper has brought us. But in spite of all the advantages we can mention, we must admit that, for some reason, the world is sick, that agriculture is depressed, that we have overreached ourselves in production, that by gaining control of the forces of production, we have apparently lost economic control and brought social distress to ourselves. Some would sarcastically and wrongly say that through technical efficiency we have bankrupted ourselves and broken our social morale. Evidently we are confused, muddled, lost even in our thinking. The way out is not to call a retreat in technical efficiency. The way out is to realize that the results of the discoveries of natural science must be intelligently handled by society, that it is not natural science which is causing grief, but rather the unintelligent application of its discoveries by society.

With the automatic device for handling increase in agricultural production going into the discard, namely, increase in population, it becomes clear that our production can run wild, and probably will, unless a science is developed within our rural society for the purpose of turning efficient production into channels of better and happier living for every one.

On the one hand, our agriculture needs a science to make us intelligent and efficient in our processes of production; on the other hand, it needs a science to make us intelligent and efficient in distributing our production and adjusting it to the logical demand for it. If the amount of production greatly exceeds the demand for it, interest in intelligent and efficient production and the science underlying it is sure to sag. If production should be unintelligent and inefficient, no system of distributing and adjusting production to demand could bring prosperity and better living to rural people. In these very simple terms, the essential relationship between the natural and social sciences in agriculture may be expressed.

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[4] The discussion in this and the two succeeding paragraphs closely parallels discussion to be found in the paper of Dean C. B. Hutchison read before the section of experiment stations, annual meeting of Association of Land Grant Colleges and Universities, Chicago, Illinois, November, 1931.

SCIENTIFIC EVENTS

THE IMPORTATION OF SCIENTIFIC SPECIMENS AND APPARATUS INTO GREAT BRITAIN

As the result of a report by the Association of British Zoologists, the council of the British Association in February, 1931, appointed a committee to consider action with a view to the amelioration of the customs regulations affecting the importation of scientific specimens and apparatus. Following upon discussion between officers of the association and the Customs House authorities, the latter have most kindly supplied the association with a memorandum on the reliefs from customs duties on scientific instruments and cinematograph films, and from the import prohibitions on plumage likely to be of use to scientific workers, together with a note on procedure in respect of the importation of scientific specimens preserved in spirit.

The memorandum on scientific instruments and cinematograph films was supplied confidentially to enable the association to advise *bona fide* scientific workers, but not for general publication, since some of the relaxations are extra-statutory and liable to modification or withdrawal as the interests of the revenue may demand. The British Association is, however, prepared to advise on specific applications from scientific workers or societies. Enquiries should be addressed to the secretary of the British Association at Burlington House, London, W.1.

It emerged in the course of discussion that some of the difficulties which have been encountered by scientific workers under the customs regulations might have been avoided by previous communication with the Board of Customs and Excise.

THE UNIVERSITY OF PORTO RICO AND THE U. S. DEPARTMENT OF AGRICULTURE

TENTATIVE arrangements for cooperation in research and extension work between the U. S. Department of Agriculture and the College of Agriculture of the University of Porto Rico, at Mayaguez, were made by Dr. C. W. Warburton, director of extension work, and by Dr. James T. Jardine, chief of the Office of Experiment Stations, in the course of a brief visit to the island, from which they returned on December 21. This cooperation was authorized by an act of congress, approved on March 4, which provided that the several experiment station and extension acts should apply to Porto Rico, beginning on July 1, with an initial appropriation of $15,000 for research and $50,000 for extension work, these sums to be increased respectively by $5,000 and $10,000 annually until the totals to which Porto Rico is entitled under the federal act are reached.

The insular government of Porto Rico now maintains an agricultural experiment station and an agricultural extension service, and these will be included in the cooperative agreement. For many years this department has maintained an experiment station at Mayaguez, the work of which will now be coordinated with that of the cooperative insular station. The extension work on the island will be expanded to include home economics and boys' and girls' club work.

"Though Porto Rico is feeling the effects of the world-wide depression severely, harvesting of the largest crop of sugar ever produced on the island is now beginning, and the unemployment situation there will be greatly relieved," according to Dr. Warburton. "Failure to sell the 1931 tobacco crop at satisfactory prices has curtailed planting for the 1932 crop, vigorous efforts having been made in some sections to secure an agreement among growers to plant no tobacco at this time. The 1931 production of coffee was very low, this crop not yet having recovered from the 1928 hurricane. Agricultural and educational agencies are conducting a vigorous campaign for the production of larger supplies of food crops for local use, in an effort to feed the rapidly increasing population and reduce the imports of foodstuffs."

TO GUADALUPE ISLAND

THE fascination of studies in island life is answerable for the latest expedition to Guadalupe, the little-visited volcanic island 140 miles west of northern Lower California. Mr. Templeton Crocker, of San Francisco, recently visited this remarkable island on his yacht *Zaca* in the interest of the California Academy of Sciences and spent three days (November 14 to 16) exploring the island and adjacent waters. Mr. Crocker was accompanied by Mr. John Thomas Howell, botanist of the California Academy of Sciences, who conducted the scientific studies. From several stations on the island collections were obtained of insects, birds, fishes, plants and land and marine shells. Although the season was at low ebb for extensive plant collections, the wet season just having begun, thirty-three collections of native vascular plants were made, four of which have not been known heretofore from the island. In addition to these vascular plants many mosses, hepatics, and lichens were collected. Among the specimens of special interest brought back is a 300-pound Giant Black Marlin Spearfish (*Makaira marlina*), an interesting big game fish recently described from the Pacific off Cape San Lucas. This specimen was taken by Mr. Crocker personally and brought to the academy, where it is now being prepared as a permanent exhibit to be placed in the Steinhart Aquarium.

A census was taken of the Guadalupe elephant seal by Mr. Crocker and Captain D. Rotch. In the large herd on the west side of the island near Elephant Rock approximately 900 individuals were counted, of which about one third were males. On a small beach on the east side of the island, near the Northeast Anchorage, 27 seals were numbered. At neither of these beaches was any seen dead, and the general condition of the animals seemed to be good. The valuable data and collections made on this expedition to Guadalupe Island make it very gratifying to know that a business man of Mr. Crocker's prominence has shown such a keen interest in the pursuit of scientific field studies.

JOHN THOMAS HOWELL

CALIFORNIA ACADEMY OF SCIENCES

PROFESSORSHIPS AT YALE UNIVERSITY IN MEMORY OF GIBBS AND SUMNER

THE memory of two distinguished professors of Yale University, Josiah Willard Gibbs and William Graham Sumner, has been perpetuated by the establishment at the university of the Josiah Willard Gibbs professorship of mathematics and the William Graham Sumner professorship of the science of society, both made possible by funds pledged in 1927 as a part of the Yale Endowment Fund and now paid to the university for this purpose.

Two members of the Yale faculty have been appointed to these professorships. The first Gibbs professor of mathematics is Dr. Ernest William Brown, previously Sterling professor of mathematics; the first Sumner professor of the science of society is Dr. Albert Galloway Keller, now professor of this subject.

Professor Brown, who has been a professor at Yale since 1907, is an authority on celestial and especially lunar mechanics. A graduate of Cambridge University (Christ's College), he has won the Royal Medal of the Royal Society, of which he is a fellow; the gold medal of the Royal Astronomical Society, and the Bruce Medal of the Astronomical Society in this country. He is a member of the National Academy of Sciences, a fellow of the American Academy of Arts and Sciences, and is a former president of the American Mathematical Society. Professor Keller has been a member of the Yale faculty since 1899. He is the author of several authoritative works in the field of social science. Professor Sumner had spent his later years collecting material for a monumental work to be known as "The Science of Society." On his death, his successor at Yale, Professor Keller, took up the work, and after twenty-five years of preparation, published four volumes under this title in 1927 through the Yale University Press which had previously issued four volumes of Sumner's collected essays under the editorship of Professor Keller.

The announcement from the office of the secretary of Yale University characterizes the work of Gibbs as follows:

> Professor Josiah Willard Gibbs, who has been called ''the first physical chemist,'' graduated from Yale College in 1858. He received the doctorate from Yale in 1863, and after tutoring at the university for one term, spent three years in Europe. In 1871 he was appointed professor of mathematical physics at Yale, a position which he held until his death in 1903. Many honors and degrees and medals came to him, among these being the Rumford Medal from the American Academy and the Copley Medal from the Royal Society of London. Although he was not in the strictest sense of the word a chemist, Professor Gibbs is generally considered to have made the greatest single contribution to theoretical chemistry made by an American. In 1876–78 he published a series of papers on ''The Equilibrium of Heterogeneous Substances.'' Because of the strictly mathematical treatment of the subject and the prevailing lack of familiarity of chemists with higher mathematics, its value was not recognized, nor was the great principle involved used by chemists for several years.
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> The great value of the ''Phase Rule,'' a principle evolved from Professor Gibbs' mathematical discussion, is now acknowledged by all working in the field of theoretical chemistry. The layman, however, does not realize the great practical use which is made of this principle first developed by Gibbs. The familiar carbon-iron diagram, which is the basis of the metallurgy of steel, is based upon it. The whole subject of alloys and the science of metallography is founded on it. The work which has explained the constitution of portland cement was only possible through this rule. These are but a few examples of its value and versatility.

AWARD OF THE FIRST RICHARDS GOLD MEDAL TO PROFESSOR ARTHUR A. NOYES

THE Richards Gold Medal for conspicuous achievement in chemistry has been awarded by the Northeastern Section of the American Chemical Society to Professor Arthur A. Noyes, director of the Gates Chemical Laboratory of the California Institute of Technology, Pasadena, according to an announcement made by Professor William P. Ryan, chairman of the section. The medal will be presented at the time of the annual meeting early next May.

The Richards Medal was established by the Northeastern Section in 1929 to commemorate the many fundamental contributions made to chemistry by the late Theodore William Richards, who was professor of chemistry in Harvard University for over twenty-five years and the only American chemist to receive the Nobel prize. He was a member of the Northeastern Section for thirty years. A trust fund of $10,000 to endow the medal has been raised by a committee consisting of Drs. Lyman C. Newell, Arthur D. Little and James F. Norris. The medal was designed by Mr. Cyrus E. Dallin, who was an intimate friend of Professor Richards.

Dr. Arthur Amos Noyes, the first recipient of the Richards Medal, was born at Newburyport, Massachusetts, in 1866. After graduation from the Massachusetts Institute of Technology he studied in Leipzig, where he received the degree of Ph.D. in 1890. He taught at the institute from 1890 to 1919, and was acting president 1907–1909. He went to the California Institute of Technology in 1915 to assist in its organization and took up permanent residence there as professor of chemistry in 1919. In recognition of his contributions to chemistry he has been elected to numerous scientific societies, has received many honorary degrees and has been awarded several medals including the Davy medal of the Royal Society of London. He is the author of books in qualitative analysis, organic chemistry and physical chemistry, and has published a large number of articles on his original researches in theoretical, analytical and organic chemistry in American and foreign journals. Professor Noyes was a charter member of the Northeastern Section of the American Chemical Society.

SCIENTIFIC NOTES AND NEWS

IN the British New Year honor list science is recognized in knighthoods conferred on Mr. George Buckston Browne, the donor of Darwin's house at Down to the British Association and of generous gifts to medical research; Dr. H. H. Dale, secretary of the Royal Society and director-in-chief of the National Institute for Medical Research; Dr. Patrick Geddes, late professor of botany at St. Andrews and professor of sociology and civics at Bombay, and Mr. H. S. Wellcome, the founder of the Wellcome Research Institution and the Wellcome Tropical Research Laboratories at Khartum.

PROFESSOR CHARLES RICHET, the physiologist, has been elected vice-president of the Paris Academy of Sciences for 1932 and will become president in 1933.

DR. HUGO ECKENER, commander of the dirigible *Graf Zeppelin*, received on January 16 the award of the 1931 medal of the International Aeronautic Federation.

M. LUCIEN CUÉNOT, professor of zoology at the University of Nancy, who in 1918 was elected a correspondent of the Paris Academy of Sciences, has now been elected a non-resident member to succeed the late M. Cosserat.

PROFESSOR E. L. NICHOLS, of the department of physics of Cornell University, has been elected an honorary member of the Association des Ingenieurs de l'Eclairage, Paris.

AT a special meeting held at the St. Louis Medical Society, by friends of Dr. Amand N. Ravold in recognition of his completion of fifty years in the practice of medicine, a plaque was presented to him by Mr. Victor Holm. Dr. Augustus G. Pohlman, Washington University School of Medicine, extended greetings; Professor Arthur I. Kendall, of the department of research bacteriology, Northwestern University Medical School, Chicago, gave an address on "Fifty Golden Years"; Dr. William W. Graves, "Amand Ravold the Builder," and Dr. Joseph Grindon, "Amand Ravold the Man."

MR. WILLIAM S. LEE, of Charlotte, North Carolina, known for his work on high-tension hydro-electric power development and transmission, has been elected president of the American Engineering Council. He is president of the W. S. Lee Engineering Corporation and vice-chairman of the Duke Endowment.

DR. SCOTT TURNER, chief of the U. S. Bureau of Mines, has been nominated for the presidency of the American Institute of Mining and Metallurgical Engineers for 1932.

OFFICERS elected at the twenty-fourth annual meeting at Atlantic City of the American Institute of Chemical Engineers were as follows: J. V. N. Dorr, *president;* A. E. Marshall, *vice-president;* F. J. LeMaistre, *secretary;* Martin H. Ittner, *treasurer;* David Wesson, *auditor,* and H. C. Parmelee, Willard Dow, J. G. Vail and R. T. Haslam, *directors.*

DR. R. S. BASSLER, since 1929 head curator at the U. S. National Museum and professor of geology at George Washington University, was elected president of the Paleontological Society of America and vice-president of the Geological Society of America at the recent meetings at Tulsa, Oklahoma.

AT the annual meeting of the Mineralogical Society of America, held at Tulsa, from December 29 to 31, the following officers and fellows were elected: *President,* Alexander N. Winchell, University of Wisconsin; *Vice-president,* Joseph L. Gillson, E. I. du Pont de Nemours and Company, Delaware; *Treasurer,* Waldemar T. Schaller, U. S. Geological Survey; *Secretary,* Frank R. Van Horn, Case School of Applied Science; *Editor,* Walter F. Hunt, University of Michigan; *Councilor,* 1932–1935, William J. McCaughey, the Ohio State University. The following fellows were elected: Dr. Olaf Anderson, Research Laboratory, United States Steel Corporation, Kearny, New Jersey; Dr. Richard C. Emmons, assistant professor of geology, University of Wisconsin, and Dr. James E. Hawley, professor of mineralogy, Queen's University, Canada.

AT the annual meeting of the American Society of Tropical Medicine held in conjunction with the meeting of the Southern Medical Association at New Orleans, from November 18 to 20, the following officers were elected for the ensuing year: *President,* Dr. Frank Smithies, Chicago; *First Vice-president,* Dr. E. L. Walker, San Francisco; *Second Vice-president,* Dr. G. R. Callender, Washington; *Secretary-treasurer,* Dr. Henry E. Meleney, Nashville; *Assistant Secretary,* Dr. Dámaso de Rivas, Philadelphia; *Councillors,* Dr. Dámaso de Rivas, Philadelphia; Dr. B. C. Crowell, Chicago; Dr. E. B. Vedder, Washington; Dr. E. C. Faust, New Orleans, and Dr. H. C. Clark, Panama.

AT the meeting of the Botanical Society of America in New Orleans the Mycological Section voted the establishment of an independent mycological society. Dr. William H. Weston, of Harvard University, was elected president and Dr. H. M. Fitzpatrick, of Cornell University, secretary. A committee of five, including the officers mentioned, was appointed to draw up a constitution and by-laws and negotiate with the New York Botanical Garden looking toward an agreement whereby *Mycologia,* now published by the New York Botanical Garden, can be adopted as the official organ of the newly formed Mycological Society of America. The results of these negotiations will be reported at the meeting held in connection with those of the American Association for the Advancement of Science in Atlantic City next winter.

THE dismissal of Dr. Carl C. Taylor, dean of the Graduate School at the State College of Agriculture and Engineering of North Carolina on June 8, 1931, is found by the committee on academic freedom and tenure of the American Association of University Professors to be "unusual" and to have been caused by other motives than the officially announced necessity of reduced budget. The summary action of the trustees of the college in discharging "the most distinguished member of the faculty" is analyzed by Professor Holland Thompson, of the College of the City of New York, a native of North Carolina, who made the investigation at the request of the committee, and is described by him as arising from several possible causes. The determining factor, however, is declared to be the personal "tension which had developed" between President E. C. Brooks and Dr. Taylor over several years.

DR. ELLIOT CARR CUTLER, director in surgery at the Cleveland Lakeside Hospital and professor of surgery in the Medical School of Western Reserve University, has been appointed Moseley professor of surgery at the Harvard Medical School and surgeon-in-chief at the Peter Bent Brigham Hospital, to succeed Dr. Harvey Cushing, whose resignation takes effect on September 1 after a service of twenty years.

DR. GEORGE BURGESS MAGRATH, medical examiner for Suffolk County, has been appointed the first holder of a new chair of legal medicine which has been founded at the Harvard Medical School. The foundation is the gift of Mrs. Frances Glessner Lee, of Littleton, New Hampshire, and has been established to support a resident professor of legal medicine and to provide for one or more lectures by visitors each year. A provision of the gift provides a plan to accumulate at the medical school a file of cases on the subject, and it is hoped that part of Dr. Magrath's records of nearly 19,000 cases may form the nucleus of this collection.

DR. JOHN CALVERT DONALDSON, associate professor of anatomy in the School of Medicine of the University of Pittsburgh, was promoted to a professorship in anatomy at the beginning of the current term.

MR. O. L. V. DE WESSELOW has been appointed to the chair of medicine at the University of London, tenable at St. Thomas's Hospital Medical School. Since 1920 he has been chemical pathologist to St. Thomas's Hospital.

IN reporting in a recent issue of SCIENCE that Dr. J. S. Plaskett has been awarded the Catherine Wolfe Bruce Gold Medal for the year 1932 it was stated in error that he had been appointed recently Savilian professor of astronomy at the University of Oxford. It is Dr. Plaskett's son, Dr. Harry H. Plaskett, who has become professor at Oxford.

MR. GEORGE T. SANFORD, assistant director of reclamation economics, has been appointed chief of the engineering division of the Bureau of Reclamation.

THE HONORABLE CHARLES G. DAWES, who will resign in spring as ambassador at London; Robert Walton Moore, member from Virginia of the House of Representatives from 1919 to 1931, and Senator William Cabell Bruce, Maryland, member of the upper house from 1928 to 1929, have been nominated by the Senate as members of the Board of Regents of the Smithsonian Institution.

DR. EDWARD R. WEIDLEIN and Mr. William A. Hamor, of the Mellon Institute of Industrial Research, Pittsburgh, have been appointed by Governor Pinchot to membership on the Greater Pennsylvania Council, which will be concerned with the development of agriculture, the industries, recreational facilities and community welfare in the state. Mr. Hamor has been made a member of the council's executive committee.

PROFESSOR J. O. SNYDER, of the Stanford zoological department, was recently appointed to the office of state fish culturist by the California Department of Natural Resources. He succeeds Mr. W. H. Shelby, a member of the Fish and Game Commission for the past forty-five years.

DR. E. B. COPELAND, associate curator of the herbarium and lecturer in botany at the University of California, has been granted leave of absence from March 1 to June 30, the leave to be extended later to January 31, 1933.

MR. ALVIN SEALE, superintendent of the Steinhart Aquarium of the California Academy of Sciences, has been placed in charge of the scientific work for an expedition to secure aquatic specimens in the waters around Central and South America.

AT the recent annual meeting of the British Science Masters' Association at the Imperial College of Science, London, Mr. Jocelyn Field Thorpe, F.R.S., professor of organic chemistry in the Imperial College of Science, gave an address on the new vista which organic chemistry is opening up, and its bearing on good health and long life.

MR. A. F. MOORE, having examined four high peaks in South West Africa with reference to their availability for solar-constant stations, reports to the Smithsonian Institution that none of them are as favorable as Montezuma, Chile, though one or two may be somewhat superior to Mount Brukkaros, South West Africa. The observatory at Mount Brukkaros has been discontinued and its equipment shipped to Washington. Messrs. Moore and Sordahl will now examine conditions at Mount St. Catherine in the Sinai Peninsula, ten miles south of Mount Sinai.

DR. JOHN HAMMOND, of the department of physiology at the University of Cambridge, will lecture on animal physiology at the Iowa State College of Agriculture and Mechanic Arts during the first term of the summer session of 1932.

DR. M. BODANSKY, director of the John Sealy Memorial Laboratory, Galveston, and professor of pathological chemistry at the University of Texas School of Medicine, will be visiting professor of biological chemistry at the American University of Beirut, Syria, during the fall semester of 1932–33.

DR. ANTON J. CARLSON, of the University of Chicago, gave a lecture on the "Rôle of the Nervous System in Gastro-intestinal Functions and Disorders" before the Los Angeles County Medical Association on December 22; on the previous day Dr. Carlson spoke on "The Present Status of the Problem of Endocrines" before the Clinical and Pathological Society.

PROFESSOR G. W. SNEDECOR, of the department of mathematics of the Iowa State College, gave from January 4 to 7 five lectures on "The Analysis and Interpretation of Research Data" before members of the faculty and others engaged in research work at the Louisiana State University.

IN the winter and spring Professor Thomas R. Garth, of the department of psychology at the University of Denver, has engaged to give a lecture on "Race Psychology" at various institutions in the Middle West and in the East. His itinerary will include the University of Iowa, Wellesley College, Smith College, the New School of Social Science, New York City; Davidson College, North Carolina, and Washington University, St. Louis.

THE patent obtained by Dr. Edward J. Dyce, of Cornell University, for a new product called crystal honey has been turned over to the university for use in the advancement of the honey industry.

THE Committee on Scientific Research of the American Medical Association invites applications for grants of money to aid in research on problems bearing more or less directly on clinical medicine. Preference is given to requests for moderate amounts to meet specific needs. Application forms may be obtained from the Committee at 535 North Dearborn Street, Chicago, Illinois.

AT a meeting of the executive committee of the Southwestern Division of the American Association for the Advancement of Science at Tucson on December 21, it was voted to hold the coming spring meeting of the division at Denver, April 25 to 28, inclusive, under the presidency of Dr. John D. Clark, professor of chemistry and dean of men at the University of New Mexico. On the general program will be the annual John Wesley Powell Memorial Lecture and a symposium on readjustments in the light of changed economic conditions. Scientific organizations in the territory of the Southwestern Division are especially invited to participate in the meeting. On account of the sabbatical leave of Dr. Edwin F. Carpenter, the secretary of the division, Dr. M. M. R. Schneck, of the department of psychology, University of Arizona, was appointed acting secretary until September, 1932.

AT the recent meeting of the executive committee of the American Society of Zoologists in New Orleans, it was voted to hold the next annual meeting in Atlantic City, New Jersey, from December 27 to December 29, in affiliation with the American Association for the Advancement of Science.

IT was announced at the close of the Baltimore session that the Society of American Bacteriologists will hold their next annual meeting at the University of Michigan.

On the invitation of the secretary of the Smithsonian Institution, Dr. Charles G. Abbot, and of the assistant secretary in charge of the U. S. National Museum, Dr. Alexander Wetmore, the third annual meeting of the American Association of Physical Anthropologists will be held at the U. S. National Museum, March 21, 22 and 23. This meeting will give opportunity to see or review the extensive collections of anthropological and comparative material acquired by the National Museum. For the benefit of more distant members who belong to the American Association of Anatomists also, the date of the meeting has been arranged to facilitate attendance at both conventions, the anatomists meeting in New York on the three succeeding days.

A correspondent writes: "Over five hundred members have already enrolled for the sixth international Congress of Genetics. Many of these have done so recently. Because of the past uncertainty of holding the congress, it seems probable that there are many other individuals who, now that it has been definitely decided to go ahead, will wish to join as soon as possible. For this reason the council has decided to extend the date for ten dollar memberships until May 1. After that date, the membership will be at an increased fee ($12.00). Graduate students and assistants may join as six-dollar members until May 1. After that date their memberships will be at the rate of seven dollars. Both of these revisions have been made because of the exceptional economic conditions and because the council is anxious, in so far as it is possible, to avoid having financial considerations a deterrent to memberships. The number of people who have already joined insures a representative and highly successful congress, and reveals as well the great amount of active interest in genetics at the present time. The guarantee that full proceedings will be published and that each member will receive a copy has proved to be a strong attraction, not only to geneticists but to many biologists in other fields."

Mrs. Henry Lang has presented to the Montclair Art Museum in memory of her mother, the late wife of Jasper R. Rand, who died in 1909, an addition, built at the cost of $100,000, devoted to an exhibition of American Indian material.

DISCUSSION

DEFINITION OF A MATHEMATICAL GROUP

It is just about a century ago that the word group began to be used as a mathematical term by a young Frenchman named Evariste Galois, who died before he reached the age of twenty-one, but who had at that early age inaugurated such fundamental work that he is still ranked among the 25 greatest mathematicians that ever lived and the only one among them who gained this eminence by work accomplished at such an early age. Although the concept of group had been employed occasionally in mathematics before the time of Galois his new uses thereof were probably the most influential in the vast developments relating thereto, which took place during the hundred years just closing. It is well known that these developments are now extending into such subjects as mathematical physics, where they have sometimes been called a pest, and also into elementary mathematics, as may be seen from the fifty-one pages devoted thereto in the recently published volume on analysis of the "Enciclopedia delle Matematiche Elementari."

It may be appropriate to note here in connection with the termination of the first century of the use of the mathematical term group a few elementary notions relating to its definition without entering into technical details relating thereto, especially since widely different definitions of this term appear in standard works of reference. It seems to have been always assumed therein that the distinct elements of a group satisfy the two conditions that they include the product of every pair as well as the square of every one of them. In many cases the elements are such that no other condition is necessary in order that they must constitute a group even in the most restricted sense of this term. This is true, for instance, when these elements are the permutations with respect to which groups were first studied by J. L. Lagrange, P. Ruffini, E. Galois and others. It may therefore be of interest to note here the circumstances under which one of these two conditions implies the other as regards a given set of such elements.

It is easy to see that the latter of these two conditions implies the former only in the trivial cases when the group is either the identity or of order 2. That is in every other group it is possible to find a set of distinct generating elements so that the set includes the square of each one of these elements but not the product of every pair thereof. On the contrary, the former of these two conditions implies the latter with very few elementary exceptions. One such exception is furnished by the set composed of the identity and the six elements of order 4 of the quaternion group. It is easy to verify that the set of seven elements thus obtained includes the product of every possible pair of its distinct elements but not the square of its elements of order 4. Since the quaternion group plays such an important rôle in the history of mathematics it is interesting to note that it is the only non-abelian group which involves a set of generating elements such that they satisfy the former of the two given conditions without implying the latter.

Among the abelian groups it is obvious that every cyclic group contains such a set of two operators composed of a generator of the group and the identity. When the order of a cyclic group exceeds 2 it also contains such a set of three elements composed of a generator, its inverse and the identity. When a group involves only elements of order 2 besides the identity, all its elements of this order constitute such a set. As these elementary groups are the only ones which separately involve such a set it results that when a set of distinct group elements satisfies the conditions that it includes the product of every pair of these elements and does not generate one of these elementary groups it must also involve the square of each of its elements and hence constitute a group. Since the properties noted above lie at the very door of group theory they should be of interest not only to those who desire to enter therein but also to those who wish to know only where this subject abides and whence its growing influence emanates.

G. A. MILLER

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AUTHORS' ABSTRACTS[1]

DR. LAMSON, and other readers of SCIENCE, may be interested to know, in connection with Dr. Lamson's article on *Biological Abstracts* in SCIENCE for November 13, that the principle of having authors' abstracts accompany all geological publications has been accepted by geologists.

A motion asking that the International Geological Congress recommend such abstracts was presented, by a representative of the division of geology and geography of the National Research Council, at the fifteenth session of the congress, which met in South Africa in 1929, and was passed by the congress. A year or two before that, authors' abstracts were called for in all publications of the Geologic Branch of the U. S. Geological Survey, and a committee of the branch prepared a set of suggestions for authors of abstracts. The plan of having authors' abstracts in the publications of the various state geological surveys has also been presented to the state geologists in their annual meeting and approved by them. A memorandum calling for authors' abstracts in publications of all branches of the U. S. Geological Survey has just been issued. In two geological publications, the *Journal of Geology* and the *Bulletin of the American Association of Petroleum Geologists*, authors' abstracts accompany almost all papers. Authors' abstracts of all papers to be presented at the annual meeting of the Geological Society of America are distributed before the meeting and printed in the annual volume.

As far as actual accomplishment goes, these results are still far from covering the field of geological publications. The action of the International Geological Congress is not binding in any way; it is merely a very valuable step in the promotion of the project. It has, however, created interest in the idea in other countries and led to its adoption by a number of important publications.

That ultimately the idea will be generally accepted in scientific publications can scarcely be doubted. The additional percentage of time required for an author to prepare an abstract of a paper which he has just completed is so slight that the only objection there can be to it is the additional bother; but when authors generally have fully realized the growing impossibility of keeping up with the flow of scientific literature, the unfairness of burdening their more public-spirited colleagues with the preparation of an abstract of another's paper, and the value to themselves of an abstract as a means of bringing before their busy colleagues the essence of their publication, they will be not only willing, but eager, to prepare the best possible abstract.

Biology and chemistry have perhaps solved, even under present conditions, the problem of covering with abstracts the entire field of their interests. But it is hard to believe that when those more public-spirited members of these professions, who prepare the abstracts, once realize the needlessness of their self-sacrifice, they will submit indefinitely to being made the goats. It is true that not all authors, at present, know how to prepare good abstracts of their own papers. Some authors find it hard to write an abstract much shorter than the original paper; but a study of abstracts indicates that the majority of authors' abstracts are too short and too incomplete. Either type of defect may be due to insufficient effort as well as to inexperience. But it is worth while to point out another peculiar psychological twist which leads to inadequate abstracts; that is, that some authors, in preparing abstracts, have in mind, often unconsciously, to conceal from the reader as far as possible the conclusions arrived at and, by merely indicating the subject-matter with which the paper deals, to lead the reader of their abstract to read the paper itself. If they knew how often this ruse fails they would probably soon abandon it.

Under paragraphs (1) and (2) of his discussion of the possibilities of carrying out the plan of having authors' abstracts with all biological publications, Dr. Lamson takes up the question of obtaining the cooperation of editors of biological journals and of their contributors. At first glance it would seem that so simple and reasonable a plan would obtain the immediate support of all editors. On investigation, however, a reason, and probably the only one, for hesitation on the part of some of them becomes obvious. Many journals are dependent on their subscribers for their existence. They must, therefore, obtain as many interesting papers as they can, and some of them hesitate to make any special demands on possible contributors, that might lead the contributors to offer their papers elsewhere. This difficulty, as Dr. Lamson points out, will diminish as the requirement of authors' abstracts becomes more general with the stronger, more independent publications and as authors awaken to the reasonableness and advantage of preparing abstracts of their own papers. When the expense in cash, in wasted time, and in the duplication of researches through ignorance of what has gone before (of which there are some astounding examples) is considered, it would undoubtedly be to the economic advantage, not only of science but of the community in general, to promote the preparation of authors' abstracts by a subsidy to those journals which require them of their contributors. However, time, good sense and fairmindedness will undoubtedly bring about the same result.

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[1] Published with permission of the Director of the U. S. Geological Survey.

MARCUS I. GOLDMAN
U. S. GEOLOGICAL SURVEY

THE DISTRIBUTION OF STATE AGRICULTURAL EXPERIMENT STATION BULLETINS TO FOREIGN COUNTRIES[1]

IT is recognized generally that the character of the work of the state agricultural experiment stations has undergone a gradual change during the past twenty-five or thirty years. In recent years a much larger proportion of the bulletins published are technical in nature. Many of them constitute distinct contributions to science and are of interest to agricultural workers throughout the world. If these bulletins are to justify the labor and expense involved in producing them they must be so distributed that they will be readily available to investigators in the field of agricultural science in all countries. A personal inspection of the libraries of a considerable number of European institutions of agricultural research led one of the writers to suspect that such adequate distribution was not being accomplished. A further investigation of the extent of the distribution of bulletins to foreign libraries was made by sending a questionnaire to fifty state agricultural experiment stations. The earlier suspicion was thoroughly confirmed. The agencies for distribution have not kept pace with the change in the nature of bulletins to be distributed. Distribution to libraries in the United States is adequate, but only a few states have built up a mailing list of foreign institutions of any appreciable size. Many of the foreign mailing lists consist largely of the names of individuals who have requested that their names be placed on the mailing list. Bulletins so distributed into the hands of individual workers doubtless serve a useful purpose, but it is obvious that the first responsibility of distribution is to see that a copy of the bulletin is deposited in the library of those institutions where agricultural research or teaching is in progress.

The task of securing adequate distribution of these bulletins need not be done entirely with altruistic motives. Many people familiar with the lavish way in which agricultural experiment station bulletins are distributed within the United States do not realize that nearly all research institutions in European countries make a charge for their publications and do not send them gratuitously, even to other institutions, unless exchange relations have been established. Most foreign institutions are glad to exchange publications with our state experiment stations, but are generally quite careful to see that a real exchange basis is reached. If our state experiment stations wish to receive the research publications of foreign institutions, it behooves them to see that these institutions receive their bulletins.

With help from various sources the writers have prepared for the Minnesota Agricultural Experiment Station a classified list of libraries of foreign agricultural institutions. Approximately eleven hundred libraries are included. About six hundred of these will receive all bulletins published by the experiment station. The remaining addresses are classified according to subject-matter interest and will receive those bulletins in which they are interested. The list is by no means perfect, but considerable time has been spent in an effort to make it complete, at the same time weeding out those institutions with only a superficial interest in agricultural research. It is realized that constant revision of such a list will be necessary if it is to function to the best advantage.

Attention is called to this list and to the present inadequate distribution of bulletins to foreign institutions in the hope that other states may take steps to secure better distribution of their bulletins. It is the opinion of the writers that some central agency, by proper cooperation with all the various state experiment stations, could render a distinct service to agricultural science in bringing about more efficient exchange of research publications.

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[1] Paper No. 1061 of the Journal Series of the Minnesota Agricultural Experiment Station.

J. G. Leach
H. Macy
C. H. Bailey

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St. Paul, Minnesota

AUDITORY ACTION CURRENTS

In a recent issue of Science and in subsequent publications[1], Wever and Bray have reported that action currents which were led off from the acoustic nerve and amplified were heard in a telephone as tones of the same pitch as the stimuli, a result obviously of great importance for auditory theory. Since then Adrian, and Davis and Saul have in brief notes reported the repetition of the results, although Adrian has not agreed in attributing the currents to the auditory nerve. We, too, have repeated these experiments under conditions which Wever and Bray specify as adequate, but when certain sources of error are excluded we have obtained only negative results.

In most of our experiments we have used a 5 stage amplifier, 3 stages resistance-capacity coupled and 2 power stages, transformer coupled. Tests showed that changes 20 µV in the input circuit could be distinctly heard in the telephone. (One should like to know whether the amplification figures given by Wever and Bray for their apparatus refer to voltage or power amplification, and whether they represent the theoretical or measured amplification.) In our experiments we have used both metal hooks and cotton thread electrodes; have led off from auditory nerve, brain stem, inner auditory meatus and round window; have connected electrodes to amplifier over transformer and at other times directly to grid and filament; have used both decerebrated and undecerebrated cats—but always with negative results.

Our experiments demonstrated, however, the possibility of certain purely physical causes for Wever and Bray's results which seem not to have been excluded by their checks. They report having set up a telephone line between operating room and observation room and that, for purposes of comparison, the sound stimuli were introduced alternately into the transmitter and into the cat's ear. If this is done, unless the transmitter circuit is definitely broken when sounds are introduced into the cat's ear, it is obvious that the currents in the transmitter circuit can induce upon the input circuit of the amplifying system, as in the familiar cross talk between telephone lines. Wever and Bray's steps to exclude induction as a source of error refer only to the induction possible between the sources of sound stimuli and the electrodes, but not to the type just mentioned. The mere provision of screening does not assure the exclusion of all electric and magnetic induction effects. Screening might in some cases favor a coupling of the telephone and amplifying systems instead of hindering it.

Nor is the possibility of such sources of error necessarily excluded by the physiological checks performed by Wever and Bray. The primary, input circuit of their amplifier consists in part of the animal tissues between the electrodes. Changes in the electrical properties of the tissues as a result of various physiological changes, such as the restriction of the blood supply, death of the animal and destructions of various sorts, would also change the receptivity of the circuit for induced currents. So, for example, if the induced currents in the input circuit fall beneath a certain minimum as a result of increased impedance of the animal tissues, then these currents can not be transmitted over the transformer for amplification, and the sound signals would no longer be heard in the telephone.

Induction effects of the sort mentioned are not dependent upon the presence of a transmitter system as used by Wever and Bray. Other electrical instruments in which the sound stimuli can occasion currents or modifications of current which can in turn induce upon the amplifying system may also cause such errors. In many commercial and house telephone systems, the receiver circuit is closed, even when the transmitter is hung up. The telephone receiver, because of the magnetic field always present, can of course act as a transmitter and produce variations of current that may induce corresponding variations in the amplifier. Similar effects might be produced even by a loud-speaker or mirror galvanometer that happened to be standing nearby.

We believe that the possibility of such sources of error must be definitely excluded before the Wever and Bray effect can be conclusively attributed to action currents of the acoustic nerve.

George Kreezer
Hans Darge

Berlin, Germany,
October 13, 1931

THALLIUM POISONING AND SOIL FERTILITY

Thallium sulfate has potential destructive effects on vegetation which have not received adequate attention from those advocating its use in vermin control. It probably is not the intention of the Bureau of Biological Survey and other agencies practicing vermin control to bring about the enduring sterility of the soil upon which thallium sulfate baits have been used. But there is real danger that the practice will lead to such an end, as will be evident from the observation here noted.

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[1] E. G. Wever and C. W. Bray, "The Nature of Acoustic Response," *J. Exper. Psychol.*, 13, 373–387, 1930; E. G. Wever, "Impulses from the Acoustic Nerve of the Guinea Pig, Rabbit and Rat," *Amer. J. Psychol.*, 43, 457–462, 1931; Science, 71, 215, 1930.

Thallium sulfate baits were suspended on stakes at a height of a few inches above the earth on a grassy slope in the arboretum of the Hawaiian Sugar Planters Association Experiment Station.[1] This lies in the head of the Manoa Valley near Honolulu, a region of heavy rainfall. The baits, each containing about 0.5 gm of Tl_2SO_4[2] were set out in July, 1929. At the time of my inspection, July, 1931, there was below each stake a patch of bare earth, from one to three feet long and perhaps a third as wide, upon which all vegetation was killed soon after the baits were set out. *Not a single trace of plant life was or had been apparent on these areas during the intervening two years.* While no exact records have been made, there appeared to have been no diminution in the size of these denuded areas.

Thallium sulfate scattered or placed as bait ultimately reaches the soil, whether the bait is taken or not. Under our continental conditions, where rainfall is much less than at the locality here cited, thallium sulfate would presumably be even less rapidly removed from the soil by leaching. Continued scattering of thallium sulfate baits will presumably lead to:

(a) Complete denudation of numerous small areas of pasture or range land, leading to reduction of plant yield and also perhaps to erosion or blow-hole formation.

(b) General toxicity or complete sterility of cultivated land, which may be expected to destroy its agricultural value completely for an unknown period.

Any group or organization which allows or urges the extensive use of measures entailing the possibility, even, of such results incurs grave responsibility; and any owner of agriculturally valuable land should look well to his own future before allowing thallium compounds to be spread upon his soil.

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[1] The writer is indebted to Mr. E. L. Caum, of the Hawaiian Sugar Planters Association Experiment Station, for the invitation to visit the arboretum.

[2] This corresponds very closely to the amount of Tl_2SO_4 in "a handful" of barley treated with 1 lb. of Tl_2SO_4 per 100 lbs. of grain. Dilling has reported (*Ann. Appl. Biol.*, 13: 160–167, 1926) that N/600 Tl_2SO_4 completely and irrevocably prevents the germination of seeds of *Lepidium sativum*. More dilute solutions were not studied. On this bases it might be guessed that one bait, containing 0.5 gm of Tl_2SO_4, would under average conditions sterilize not less than half a cubic foot of soil. The observations here recorded seem to suggest a slightly greater effectiveness.

ESSENTIAL FATTY ACIDS AND GOITER PRODUCING SUBSTANCES[1]

Two recent papers indicate that the writers have not yet come to a realization of the importance of the question of *iodin-fat* balance which was raised by R. McCarrison[2] and the Mellanbys,[3] but has apparently been forgotten by those authorities as well.

G. O. Burr, M. M. Burr, and W. R. Brown,[4] studying the nutritive value of cod liver oil, find that the feeding of cod liver oil does not prevent scaliness of the feet and tail in rats given their fat-free diet. They state that of the more unsaturated oils, cod liver oil is distinct in that it leaves the skin of the animals scaly, while lard, olive oil, corn oil, linseed oil, methyl linolate and methyl linolenate all produce skin free from scales and dandruff. They emphasize the fact that cod liver oil is highly unsaturated without linoleic and linolenic acids being present in appreciable quantities. Burr and Burr for some time contended that linoleic and linolenic acids must be furnished as a part of the diet in their fat deficiency experiments.

The findings of the writer and associates[5] indicate clearly that the reason why cod liver oil is ineffective in Burr's fat disease is on account of the iodin carried with it. Burr's animals, long depleted of fats and at the same time receiving KI, must be given fats lacking iodin, or the iodin-fat balance will not be restored. The significance of Burr's essential fatty acids[6] depends on their *degree* of *unsaturation* and not upon any specificity.

E. J. Bauman, Anna Cipra, and David Marine,[7] in a paper just published, have shown that goiter-producing substance in cabbage was extractive with ether from "cabbage fat." They failed to refer to the important pioneer work of McCarrison and the Mellanbys, to our own recent work and to the suggestion that we advanced[8] to the effect that their "goiter producing substance" was quite probably the *unsaturated fat* of cabbage from which they had permitted a loss of iodin.

F. E. CHIDESTER

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[1] From the Laboratories of West Virginia University, Morgantown, West Virginia. Aided by a grant from the National Research Council.

[2] *Ind. Jour. Med. Res.*, 7, 633, 1919–1920.

[3] E. and M. Mellanby, *J. Physiol.*, 55, vii–viii, 1921.

[4] *Proc. Soc. Exp. Biol. and Med.*, 28, 905, 1931.

[5] SCIENCE, 68, 42, 1928; Collecting Net, 5, Nos. 32 and 33, 1930; *Proc. Soc. Exp. Biol. and Med.*, 28, 187–189, 1930; *Anat. Rec.*, 47, 3, 304, 1930; *Med. Times and L. I. Med. Jour.*, 59, 138–9, 1931.

[6] G. O. Burr and M. M. Burr, *J. Biol. Chem.*, 82, 345, 1929; G. O. Burr and M. M. Burr, *J. Biol. Chem.*, 86, 587, 1930.

[7] *Proc. Soc. Exp. Biol. and Med.*, 28, 9, 1017–18, 1931.

[8] Chidester and Wesson, *Med. Times*, 58, 11, 319–321, 1930.

THE DISCOVERY OF THE OESTRUS CYCLE IN MAN AND OTHER MAMMALS

THE cyclical changes which take place in the uterus and the vaginal mucosa of mammals have been studied in detail within the last few years. This work received its principal impetus from the reports of Stockard and Papanicolaou[1] and of Long and Evans[2], both of which are dealing with the rat. Since then various other mammals have been investigated and Dierck[3] and others have discussed the phenomena of the oestrus cycle in the human female. The importance of this work is generally acknowledged. It should, therefore, be of some interest to call attention to early work in this field which seems to be but little known. F. A. Pouchet, in his work, "Théorie positive de l'ovulation spontanée et de la fécondation des mammifères et de l'espèce humaine, basée sur l'observation de toute la série animale," published in Paris in 1847, gave a rather detailed account illustrated by three plates, of observations which he had made upon smears from the uterus and vagina of human females and sows. He definitely recognized the regular cyclical character and the physiological importance of these phenomena. The only reference to Pouchet's book which the writer has seen in the recent literature concerning the oestrus cycle was found in the monograph by Long and Evans. Since these authors, however, refer to Pouchet only as authority for spontaneous ovulation, and since they state that the first description of changes in the vaginal mucosa was given by Morau in 1889, it may be inferred that they had not seen Pouchet's original book.

WALTER LANDAUER

STORRS, CONN.

CHROMOSOME NUMBERS IN ULMUS

THE first report on chromosome number in this genus was by Krause in 1929. He reported fourteen chromosomes as the haploid number for *Ulmus montana* With. In some unpublished work Krause has reported that the haploid number of chromosomes for *Ulmus americana* L. is 14 and for *U. campestris* L. is 14+.

Flower buds of *Ulmus pumila* L., *U. fulva* Michx., and *U. americana* L. were collected during the spring of 1931. Belling's aceto-carmine method was used to determine the stage in development of the buds at which division figures appeared. Fixations were made of such material, and chromosome counts were made from polar views of equatorial plates of both heterotypic and homeotypic divisions. It appears that the haploid chromosome number of *U. pumila* and of *U. fulva* is fifteen and that that of *U. americana* is twenty-eight or thirty. The apparent variation in the case of *U. americana* may possibly represent a difference between individual trees.

A study of the chromosomes in somatic cells is planned as well as a more detailed study of the chromosomes during meiosis.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PHOTOMICROGRAPHY WITH A VEST POCKET CAMERA

THE method of adapting a box camera for photomicrography given in a recent issue of SCIENCE[1] by Mr. Apgar suggests a simpler solution of the problem which I used some time ago.[2] A vest pocket kodak can be used to make photomicrographs by setting it over the ocular of the microscope without additional focusing apparatus. The series with the f. 6.9 lens in a focusing mount fits the ocular very well, as the rolled edge of the microscope ocular makes a light-tight connection with the lens mounting, and the camera is so balanced that no additional support is needed. The manufacture of this very useful kodak has been discontinued, but it may be obtained for a nominal sum from dealers having second-hand kodaks. Other cameras of similar size may also be used.

When the draw tube of the microscope is extended to the proper distance of 160 mm (Leitz 170 mm) and the microscope focused sharply with the normal eye or with an eye properly fitted with spectacles a sharp picture may be obtained when the camera lens is set at infinity. If the draw tube is not extended to the proper distance a minus lens of the proper focal length must be placed over the eyepiece when the microscope is focused but removed before the camera is placed on the microscope.[3] Having the draw tube closed prevents any slipping due to the weight of the camera and does not greatly reduce the definition of the microscope. With one microscope that I used in this way, a –9 dioptera lens gave the necessary correction. The actual amount of correction needed will depend on the instrument used, so the above figures merely indicates the approximate magnitude of required lens.

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[1] *American Journal of Anatomy*, Vol. 22, 1917.

[2] "Memoirs of the University of California," Vol. 6, 1922.

[3] Archiv für Gynäkologie, Vol. 130, 1927.

[1] C. E. Apgar, SCIENCE, 74: 487–8, 1931.

[2] O. W. Richards, *Bot. Gaz.*, 86: 93–101, 1928.

[3] This suggestion comes from Foot and Strobel, quoted by M. F. Guyer in "Animal Micrology," p. 150, Chicago, 1921.

It is preferable to use the microscope at the proper tube length for the greatest definition, and this can be done if a rubber ring cut from a piece of rubber hose is placed around the draw tube to prevent telescoping from the weight of the camera. Many modern microscopes have the draw tube fixed at the proper length, so no additional friction is needed.

The use of the vest pocket kodak with the autographic feature allows permanent labeling of the negatives, which can not be done with the box camera. The magnification obtained will depend on the lens on the camera and the distance from the lens to the film. It can be obtained easily by photographing a stage micrometer. When it is desirable to reduce the cost of the negative film an insert can be made to reduce the opening in the back of the camera, cut from the thin aluminum of an ordinary cookie tin, and less expensive moving picture film used. The distance that the film is to be turned ahead between pictures can be noted by extending the opening on the back of the camera to the edge of the film and counting the perforations of the film through a red window as the film is wound. The disadvantage of this method is that the camera must be loaded and unloaded in the dark room or in a changing bag. In the previous work[2] I used an insert with an opening of 1 x 1½″, which is twice the size of the cinema frame and thereby reduced the cost of the negatives to about one cent per exposure.

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A NEW TECHNIQUE FOR OBTAINING OOSPORES OF THE HOP DOWNY MILDEW BY INOCULATING COTYLEDONS

FIELD observations in the Fraser Valley, British Columbia, in 1930, showed that young hop seedlings were badly infected with the hop downy mildew, *Pseudoperonospora Humuli* (Miy. and Tak.) Wilson. Cotyledons and primary leaves were covered with conidiophores bearing conidia.

Following this observation hop seed were gathered from plants of the clusters variety and sown in flats in the laboratory in 1931. As the cotyledons and young primary leaves appeared, they were inoculated by placing on them minute portions of infected leaves obtained from diseased "basal spikes." The seedlings had been previously moistened. The seedlings were afterwards covered with vials so as to maintain maximum humidity. They were grown in the basement of the laboratory, where the temperature remained fairly constant at 58° to 65° F. The seedlings were moistened with water each day.

After a period of six days, the time varying with different seedlings, it was noticed that the cotyledons showed signs of "damping off." Microscopic examination of the cotyledons showed that no conidiophores had developed, but on teasing out the tissue, it was found that oogonia and oospores were present in abundance. Approximately eighty oospores were found in each cotyledon, giving an average of 160 oospores per seedling. The oospore dimensions corresponded with those reported by other workers, ranging between 23 and 37 μ. Further work revealed that when maximum humidity was not maintained, conidiophores bearing conidia were produced, as well as oospores.

At present it is possible to collect abundant oospore material by inoculating hop seedling cotyledons in the manner described and gathering the latter when they show signs of damping off. By this method it will also be possible to obtain conidia for experimental purposes in the greenhouse during the winter period.

The writer considers that this technique of inoculating cotyledons may be applicable to other members of the Phycomycetes, which means a great saving of time for the worker who wishes to examine oospore material within the host.

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SPECIAL ARTICLES

ON THE VARIATION OF THE OXYGEN CONTENT OF CULTURAL SOLUTIONS

EARLIER observations led to the conclusion that there may be a translocation of oxygen from the shoot to the root of plants when the shoot is in sunlight and the root is in soil.[1] The present note records observations, to be published in detail elsewhere, that a similar movement of oxygen may take place when the roots of plants are in cultural solutions, particularly in distilled water.

The plants referred to are willow, cotton, corn and sunflower. These were grown in a standard culture solution and were transferred to distilled water for

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[1] W. A. Cannon, ''Studies on Roots,'' Carnegie Institution of Washington. Year Book No. 25, p. 317, 1925–26.

The investigation was carried on in part with the aid of a grant from the American Association for the Advancement of Science.

the tests only but were kept ordinarily in the culture solution. One willow cutting, or three of the plants, were placed in each glass jar, darkened always and of one-quart size. The cultures were subjected to two- or three-hour periods, alternately, of sunlight and of dense shade, and were covered with bell glasses over which a spray of water was constantly played. By this means the temperature both of the solutions and of the bell glasses was kept fairly low and constant, and, also, the atmosphere of the bell glasses was maintained highly humid. Fresh distilled water was used in each period.

The series of experiments of August 12 to 21 on the sunflower will serve to illustrate the leading results obtained by a study of all the plants, except only corn, which will be referred to below.

In these experiments two periods were selected each day for the tests. Of these one ran from 8 to 11 A. M. and the other from 11 A. M. to 2 P. M. Except in one instance the plants were kept in shade during the first of the periods and were exposed directly to sunlight during the second. The temperatures of the bell glasses and solutions were recorded in each test, and, at the same time, the amount of oxygen was determined. The results may be briefly given. In every instance more oxygen was found in the cultures exposed to sunlight than in those kept in shade. The difference was about 10 per cent.

In further account of the experiments it should be stated that the temperature of the bell glasses in the sunlight, and of the solutions as well, was higher than that of the solutions and bell glasses in the shade. As the rate of respiration, at the temperatures used, varies directly with the temperature, it would be expected that where the temperature was low the oxygen content would be high, and *vice versa,* but the opposite was found to be the case. That is to say, the greatest amount of oxygen was in the solutions with the highest temperatures. But these were also in sunlight, or at least the plants growing in them were in direct sunlight. The conclusions, therefore, seem warranted that there is an important relation, even if an indirect one, between evolution of oxygen in photosynthesis and the variation of the oxygen content of the solution as noted above. Thus it appears that oxygen, liberated in the course of carbon dioxide assimilation in chlorophyll bearing organs and in light, moves downward toward and ultimately into the root to fill wholly or in part its requirements for oxygen. Thus the root may apparently secure its oxygen supply from one of two sources: from the plant itself, internal oxygen,[2] and from the immediate environment. Whether this is the case under "natural" conditions, as it has been found to be in the experiments, remains to be seen. However that may be, that oxygen taking its origin in this manner constitutes a large proportion of what the root may ordinarily use seems quite possible, and under conditions similar to those employed in the experiments reported, it is more than probable.

It has already been mentioned that corn was found to be an exception to the effect, although indirect, of sunlight on the oxygen content of solutions similar to those in which the sunflower, cotton and willow were growing. To show this it will suffice to summarize one representative series of tests. In this series in which the temperature varied in the same direction as that in the experiments on sunflower above cited, but in which the variation was not so great, the oxygen concentration of the cultures in sunlight was always less than the concentration in the shade tests. It was found, in short, that the roots of plants exposed to sunlight absorbed about 14 per cent. more oxygen than did those of shaded specimens. This suggests either that the rate of respiration of the roots of the plants which had been in sunlight was high because of the higher temperature, or more rapid than the supply of internal oxygen from the shoot, or perhaps that the latter was wanting. However this may be, it can be pointed out that at temperatures favorable for a rapid rate of root growth corn appears to require an exceptionally good supply of oxygen.[3] Whether, on the other hand, such a form as willow, which does not appear to have a high oxygen requirement for root growth, may depend importantly on the shoot for its oxygen supply is another matter but may well be the case. It either is in solution or is a gas. In whatever state or in whatever way the internal oxygen may move from one part of the plant to another, whether molar or molecular, or both, presents no especial difficulty. In the event that it is tied up with the movements of solutions it yet can make its way from tissue to tissue and from the shoot to the root. Downward movement of solutions in plants are well known. This may even extend to the root where, as in the present study, movement of a solution from the leaves to and well into the roots of sunflowers was demonstrated to take place. It thus appears possible that internal oxygen may take an important part in the aeration of plant tissues, whether they are of the shoot or of the root, although whether this is of general occurrence among land plants must remain for further investigation.

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[2] G. F. Beardsley, and W. A. Cannon, "Note on the Effects of a Mud-flow at Mt. Shasta on the Vegetation," *Ecology,* 11, 1930.

[3] W. A. Cannon, "Physiological Features of Roots," Pub. No. 368, Carnegie Inst. Washington, 1925.

A DIAPORTHE CANKER OF AMERICAN ELM

Within the past few years specimens of American elm affected by a canker disease were collected from two different localities in eastern Massachusetts. Specimens from one locality consisted of dead branches, bearing large conspicuous cankers which in many cases had girdled the branches. Many of the diseased areas were hypertrophied, with margins of thick cork layers surrounding areas of exposed wood. In some cases the branches appeared to be twisted because of the irregular semi-spiral arrangement of several contiguous and much calloused cankers. The other specimens bore cankers in a younger stage of development partially girdling the branches. The diseased areas were slightly depressed, roughened and cracked along the margin. The surface of the cankers was covered with small pustules. On one of the branches the canker extended through several nodes and was sharply delimited by a definitely raised layer of cork. Branching out from this diseased area was a young twig, which had been killed back. The new growth was stunted and the leaves had become brown and dry before reaching maturity.

The pycnidia on the host are solitary, black, smooth, carbonous, ostiolate with short necks, conical or elliptical. The pycnidial cavity is irregularly shaped because of the protrusions of the basal layers. No compound pycnidia were observed in any sections. The spores formed in the pycnidia are of two types, the alpha spores and the beta spores or so-called stylospores. Both the alpha and beta spores are produced on the same type of sporophore, which is subulate or clavate, persistent, and measures approximately 11.2–15.2 μ x 2.8–5.2 μ. The alpha spores on the host and from the twig cultures are hyaline, one-celled, biguttulate, ovoid or elliptical with subacute extremities but occasionally with narrow pointed ends. The standard range of one hundred spores from the host was 6.5–8.2 μ x 2.7–3.5 μ, while that of one hundred spores from twig cultures was 7.1–8.8 μ x 3.1–4 μ. The beta spores are long, cylindrical, hyaline, one-celled, usually hamate and tapering to a point at the curved end. The standard range of one hundred spores was 22.7–27.5 μ x .98–1.3 μ.

The perithecia were obtained in cultures on sterilized twigs and on malt agar. On the twigs the perithecial stage is indicated by the appearance of protruding corrugated black beaks. The perithecia are single or clustered, always separately erumpent, membranous, leathery, globose, and measure approximately 400 μ x 385 μ. They are usually in darkened effuse stromatic areas, and beneath these dark marginal zones lines develop in the wood. The beaks are elongate, slender, projecting about 5 mm from the surface of the twig. The interior of the necks is lined with periphyses. The asci are cylindrical, clavate, and measure approximately 33–50 μ x 5.1–6.9 μ. At the apex of the ascus the wall is much thickened and the pore is surrounded by a refractive ring. Paraphyses are usually present; they are long, slender, sinuous, continuous, simple, without bulbous tips, and with granular contents. The ascospores are uniseriate or biseriate, two-celled, hyaline, slightly constricted at the septum, four-guttulate, granular, with a standard range of 10.9–12.3 μ x 3.8–4.5 μ for one hundred spores.

Naturally it was of interest to determine if possible the exact identity of this fungus, which apparently caused a pronounced canker disease of American elm. According to the description given by Gaüman[1] following Von Höhnel's classification, the ascospore stage should be placed in the rearranged family Diaporthaceae because of the sessile asci which break away from the hymenial layer at maturity. The fungus seems to correspond with the genus Diaporthe as described by Wehmeyer[2], since it has hyaline, ellipsoid, two-celled spores and forms a dark marginal zone line in the wood. The conidial stage of the fungus studied also seems to correspond with the form genus Phomopsis reported by Wehmeyer. The following five species of Diaporthe described by Saccardo[3] were carefully compared with the fungus studied: *D. protracta* Nke., *D. perjuncta* Niessl., *D. discutiens* Sacc., *D. Malbranchei* Sacc., *D. eres* Nke. The description of *D. eres*, however, corresponds most closely. The descriptions of species of Phomopsis on elm are so fragmentary that a satisfactory comparison of species is extremely difficult. However, seven species described by Saccardo have been compared with the Phomopsis now being studied. *Phomopsis oblonga* Sacc. has been most completely described and appears to resemble this Phomopsis. Saccardo considers *Ph. oblonga* with alpha spores 6–7 μ x 3 μ and beta spores 33 x 1 μ to be the imperfect stage of *Diaporthe eres.* Grove[4] on the other hand reports *Ph. eres* Sacc. with alpha spores 9–10 μ x 2.5–3 μ and beta spores 25–30 μ x 1 μ as the imperfect stage of *D. eres.* Grove mentions that Saccardo has suggested that *Ph. oblonga* and *Ph. eres* are the same, although Saccardo gives distinctly different spore measurements for each. It is impossible to state the exact identity of either the Diaporthe or the Phomopsis of the present study, since type specimens were not available for comparison.

[1] E. Gaüman, "Vergleichende Morphologie der Pilze." Jena, 1926.

[2] L. E. Wehmeyer, "A Biologic and Phylogenetic Study of the Stromatic Sphaeriales." *Am. Jour. of Bot.*, 13: 575–645, 1926.

[3] P. A. Saccardo, "Sylloge Fungorum." Vols. 1 to 24. Padua, 1882–1926.

[4] W. B. Grove, "New or Noteworthy Fungi, Pt. VI, *Phomopsis eres* Sacc." *Jour. of Bot.*, 56: 285–294, 1918.

Buisman[5] described a species of Phomopsis causing a canker on elm trees in Holland. As a result of cultural comparisons with cultures loaned through the courtesy of Dr. Buisman it appears that the organism isolated by her corresponds for the most part with that of the present study.

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A NEW BACTERIAL DISEASE OF PEARS

IN the course of an investigation on the green fluorescent bacterial plant pathogenes, a very pathogenic organism belonging to this group was obtained from a plate given me by Mr. K. G. Parker who was at the time isolating *Erwinia amylovora*. The isolation was made from colonies with green pigments in the medium, appearing as a contamination. The presence of such green fluorescent organisms in isolation work is not an unusual occurrence. Frequently they are discarded as saprophytes, in some cases with good reasons. Their presence is usually given no significance because of their ubiquitous nature in plants, seeds, water and soil.

There is practically no information as to the relation these organisms have to economic plants. There is, however, an increasing realization that some of them are plant pathogenes. The organism here described is such an example and has not heretofore been known.

SYMPTOMS OF THE DISEASE

The manifestation of blight on flowers, which turn dark brown and die, is very apparent. On matured leaves, black round spots are produced, while on young leaves similar spots have a yellow "halo" and the leaves often become distorted. Black, almost circular spots are produced on young and mature fruits, but more readily on the latter.

PATHOGENICITY

Artificial inoculations on fruits, flowers, leaves and stems of a hybrid pear, *Pyrus communis* × *serotina*, clearly established the pathogenic nature of the organism. Cross inoculations revealed a wide range of hosts. Infection was obtained on *Vigna sinensis*, *Phaseolus vulgaris*, *Purearia hirsuta*, *Vicia faba* and *Syringa vulgaris*.

A study of the organism showed it to be a *Pseudomonas*, but a comparison with the descriptions of the known species of these bacterial plant pathogenes found on pear, *Pseudomonas barkeri* and *Pseudomonas nectarophila*, showed no identity. Its fluorescigenic character is readily observed in a medium consisting of 0.3 gm $MgSO_4$, 2 gm K_2HPO_4 and 3 gm asparagine per liter, adjusted to about pH 6.9. It is closely related to *Pseudomonas syringae*, *Pseudomonas vignae* and *Pseudomonas viridiflava*, but distinctly not identical to any of these species. The organism is named and briefly described.

Pseudomonas utiformica sp. nov.

Motile by one to two polar flagella; rods with rounded ends; 0.7–1.5 x 1.3–3.1 μ, occurring singly and in pairs; no spores; no capsules; gram-negative; not acid-fast; facultative anaerobe; green fluorescent; beef-extract agar colonies round or fimbriate, grayish white to slightly greenish; nutrient broth fairly turbid in 24 hours; gelatine liquefied; milk not curdled, alkaline; nitrate not reduced or weakly reduced; ammonia produced; H_2S and indol not produced; dextrose, galactose, levulose, mannose, arabinose, xylose, sucrose, raffinose, manitol, glycerol, and salicin are fermented; no fermentation in rhamnose, maltose, lactose; starch and cellulose not digested; growth in malic, citric, succinic, formic, and lactic acids; no growth in tartaric acid.

Pathogenic on: *Pyrus communis* × *serotina*, *Vigna sinensis*, *Phaseolus vulgaris*, *Pueraria hirsuta*, *Vicia faba*, *Beta vulgaris*, *Syringa vulgaris*, *Prunus avium*.

The genus *Pseudomonas* is used according to Bergey's definition and as proposed by Burkholder. If the S. A. B. committee's recommendation for plant pathogenes is adopted the genus should be *Phytomonas*.

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THE PRODUCTION OF MUCIFICATION OF THE VAGINAL EPITHELIUM OF RODENTS BY THE OESTROUS HORMONE

THE production of vaginal mucification by *corpus luteum* extracts which maintain pregnancy in overiectomized pregnant animals, as described in a recent article in SCIENCE by Harris and Newman,[1] is, we believe, not a test for progestin but a test for the small amount of oestrin which the extracts used by them undoubtedly contain. In 1928, one of us, (R. K. M.) with Hisaw and Weichert,[2] described the production of a similar reaction in the rat with *corpus luteum* extracts. Shortly after, in 1929, the other, (W. M. A.) with Corner,[3] described the production of progestational proliferation in the castrated rabbit with extracts of *corpora lutea.*

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[5] J. Westerdijk and C. Buisman, "De iepenziekte rapport over het onderzoek verricht op verzoek can de Nederlandsch heidemaatschappij." pp. 56–62, 1929.

[1] R. G. Harris and D. M. Newman, "A Practical Test for Potency of Extracts of *Corpora Lutea.*" SCIENCE, 74, 182, 1931.

[2] F. L. Hisaw, R. K. Meyer and C. K. Weichert, "Inhibition of Ovulation and Associated Histological Changes." *Proc. Soc. Ex. Biol. Med.*, 25, 754, 1928.

[3] G. W. Corner and W. M. Allen, "Physiology of the *Corpus Luteum.* II. Production of a Special Uterine Reaction (Progestational Proliferation) by Extracts of the *Corpus Luteum.*" *Am. Jour. Physiol*, 88, 326, 1929.

During the past year we have been fortunate enough to have the opportunity of working jointly in the same laboratory on these reactions in an attempt to ascertain whether progestin produces mucification. While engaged in this task, Robson, 1931[4], reported the production of vaginal mucification in mice with progestin-containing extracts which had been treated with alkali. The details were not given but the fact that progestin is readily destroyed by alkali makes these experiments of Robson quite significant. Furthermore, he was able to produce the reaction with small amounts of oestrin prepared from follicle fluid, the dose used being one half that necessary to produce cornification.

Previously to the report of Robson we had been able to produce mucification in the rat with *corpus luteum* extracts made by extracting the fresh tissue with acid alcohol, boiling alcohol, or benzene, active material being obtained regardless of the solvent used. These extracts also always produced progestational proliferation in the adult castrated rabbit and therefore contained progestin. The extracts we had used were quite crude and probably contained oestrin, since no chemical procedure was used which would absolutely remove it. Similarly, none of those experimenters[1, 2, 4, 5, 6, 7] who have produced mucification by *corpus luteum* extracts have proved that the extracts used did not contain oestrin. On the contrary, analysis of the methods used by these workers makes it quite certain that they all did contain oestrin. These findings led us to carry out experiments designed to produce mucification with standardized oestrin-containing preparations.

When the article by Harris and Newman appeared we had been able to produce mucification in the guinea-pig and mouse by continued dosage with small amounts of Squibb's amniotin (an oestrogenic preparation from the amniotic liquor of cattle). This did not of course do more than indicate that oestrin might be the factor. Since then we have produced mucification in one adult guinea-pig, new-born guinea-pigs, mice, and rats with Parke, Davis and Company's theelin (crystalline oestrogenic preparation from the urine of pregnant women). Being producible by theelin, it seems fairly evident that the mucification is not due to progestin since in the preparation of theelin hot aqueous alkali is used, a procedure which destroys the activity of progestin. We feel, therefore, that the ability of theelin to produce mucification makes it reasonable to suppose that those who have produced mucification with *corpus luteum* extracts were obtaining a result due to the oestrin present and not to other specific hormones which they contained (progestin, relaxin).

The method we have used in general is to castrate adult rats, mice, and guinea-pigs in heat and to start injections with the oestrin preparation the next day and to continue for many days. The vaginal reaction was carefully studied by daily smears and by serial biopsies in the rats and guinea-pigs. The biopsy method was very satisfactory, in the guinea-pigs especially, and certainly facilitated greatly the progress of the work. In the guinea-pig 0.5 r.u. for about 25 days will bring about mucification equal to that seen early in the second month of pregnancy but not equal to that seen 24 hours *antepartum.* In the mouse mucification indistinguishable from that of even late pregnancy is produced by 0.04–0.06 r.u. per day for 8 days. Similarly in the rat good mucification has been obtained but the exact dosage has not been as carefully ascertained. We have also produced good mucification in new-born female guinea-pigs by giving 5.0 r.u. per day for 4 days. Mucification has also been produced in mice with oestrin made by extracting male urine with benzene, thus showing that oestrin made from a source other than the female organism is capable of producing the result.

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BOOKS RECEIVED

ACHILLES, PAUL S., Editor. *Psychology at Work.* Pp. xiii + 260. Illustrated. Whittlesey House, McGraw-Hill. $2.50.

British Association for the Advancement of Science. Mathematical Tables. J. HENDERSON, Editor. Vol. I. Pp. xxxvi + 72. The Association, London.

BURKE, JOHN B. *The Emergence of Life.* Pp. ix + 396. Oxford University Press. $7.50.

CAUSEY, DAVID. *Uninvited Guests.* Pp. xix + 120. 44 figures. Knopf. $2.00.

GARNETT, A. CAMPBELL. *The Mind in Action.* Pp. xiv + 226. Appleton. $2.00.

NELSON, GEORGE E. *The Introductory Biological Sciences in the Liberal Arts College.* Pp. viii + 135. Teachers College, Columbia University. $1.50.

SCHMIDT, ERICH F. *Anatolia Through the Ages.* Pp. x + 165. 213 figures. University of Chicago Press. $2.00.

The World Almanac and Book of Facts, 1932. 47th edition. Pp. 944. World-Telegram. $.50.

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[4] J. M. Robson, "Mucification in the Mature Mouse Caused by Oestrin." *Jour. Physiol.*, 71, p. iii of *Proceedings of the Physiological Society,* 1931.

[5] B. P. Wiesner and J. S. Patel, "The Beta-Hormone." *Nature,* 123, 449, 1929.

[6] Eric Fels, "Zur Frage des *Corpus luteum* Hormons und Seines Specifischen Testes." *Zent. für Gynäk,* 55, 514, 1931.

[7] C. Clauberg, "Experimentelle Untersuchungen zur Frage eines *Mäusetestes fur das Hormon das Corpus luteum.*" *Zent. für Gynäk,* 54, 1154, 1930b.

[8] National Research Fellow in the Biological Sciences.

SCIENCE

Vol. 75 Friday, January 29, 1932 No. 1935

The American Association for the Advancement of Science:
Reality in Physics: Dr. W. F. G. Swann 113

The Changing Bacteria: Professor C.-E. A. Winslow 121

Scientific Events:
The Annual Exhibit of the British Physical and Optical Societies; The Federal Appropriations for Agricultural Research; The International Congress of Pure and Applied Chemistry; Award to Dr. Charles H. Herty; In Honor of Herman LeRoy Fairchild 123

Scientific Notes and News 127

Discussion:
Relative to the Expression "Line Contour": Professor W. H. Wright. *"Strath" as a Geomorphic Term:* Dr. Walter H. Bucher. *Oestrus:* Dr. S. A. Asdell. *Boughs, Butts and Beaver Dams:* Dr. Charles E. Johnson. *Twisted Trees:* Dr. Neale F. Howard. *"Rickettsia" and "Symbionts":* Professor I. J. Kligler and M. Ashner 130

Reports:
Formal Opening of the New Bermuda Biological Station for Research: Professor Edwin G. Conklin 133

Scientific Apparatus and Laboratory Methods:
A Convenient Preparation for the Removal of Hair: Dr. Emmett B. Carmichael. *Air Control of Manometer Writing Points:* Dr. Paul D. Lamson 136

Special Articles:
Pre-carboniferous Foraminifera: Professor Carey Croneis, Paul H. Dunn and David Hunter. *Treatment of Cotton Root-rot with Ammonia:* Dr. D. C. Neal, R. E. Wester and K. C. Gunn. *Prevention of Blood Coagulation by Cysteine:* Professor J. Howard Mueller and Sommers Sturgis 138

Science News 8

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REALITY IN PHYSICS[1]

By Dr. W. F. G. SWANN

DIRECTOR OF THE BARTOL RESEARCH FOUNDATION OF THE FRANKLIN INSTITUTE

I SUPPOSE there are few things concerning which one could find so many differences of opinion as the question of what constitutes a theory in physical science. The pure mathematician would probably be content with a procedure of the following kind. He will set up a branch of mathematics founded upon certain postulates having to do with quantities, letters, etc., that he chooses to be talking about. In this mathematical scheme, there will appear relationships between certain quantities which occur in the mathematics, and it will be his hope to invent a scheme of mathematics of this kind which shall form an analogue of the regularities of nature in the sense that there may be a one-to-one correspondence between certain things in the mathematics and the observable phenomena in nature. It has been said that the pure mathematician is never as happy as when he does not know what he is talking about; and, in the foregoing method, he establishes contacts with the physical world with a minimum degree of shock to his own conscience, by a procedure in which he ceases to think of anything physical until he has completed his mathematical structure, and confines all physical contamination of that structure to the act of setting up the correspondence to which I have already referred. When the correspondence has been set up, the postulates of his mathematics become the laws of nature in the physics. It is possible that he may choose his postulates in various ways. In the journeys which he takes from his postulates as starting points, he arrives at multitudes of conclusions. He might gather together a suitable collection of these at any stage and take them as his starting point, and continue his reasoning backwards and forwards over the whole realm of logical regularity which he traversed before. In his journey through the realm of the abstract mathematical thought of his theory, he may stop or start at various stations. Where will he prefer to start? He will probably prefer to start at the place where the number of his postulates is a minimum. To him, a good theory will be one in which by saying few things he can deduce, as their consequence, many things. The value of his theory to the physicist will lie in the fact that it not only correlates the phenomena which he, the physicist, has discovered, but suggests multitudes of other phenomena which he may look for, and also suggests ways of viewing the interrelationships between the phenomena already studied other than those which he has already adopted. The physicist may have taken an intellectual journey from the set of phenomena "A" to the set of phenomena "B," analogous to my taking a journey from Philadelphia to Washington via the Rocky Mountains, California and New Orleans, and the complete mathematical structure may show that shorter journeys, analogous to my going from Philadelphia to Washington through Baltimore could be made.

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[1] Address of the president of the American Physical Society given at New Orleans on December 30, 1931.

The postulates which are agreeable to the pure mathematician will not necessarily be agreeable to the physicist, because the latter thinks that he knows what he is talking about and glories in the fact. It will be little consolation to the physicist to know that by the assumption of few things he may deduce many, provided that he is not content as to the reason for those few things. He would like to start with the idea that the few things are not purely arbitrary postulates but, after all, are very reasonable. He likes to adorn those postulates with some kind of a raiment which makes them seem as though they had come from somewhere, even though he does not know where. When he is presented with Newton's law of gravitation in the cold-blooded form that the acceleration of a particle is to be calculated as the sum of a number of contributions associated with the various elements of matter in the universe, each element producing an effect inversely proportional to the square of its distance from the particle in question, it is not enough for him that in this simple postulate he has said something from which very many beautiful things may be deduced. It is not enough that this postulate gives for him the orbits of the planets, the times of recurrence of eclipses, the times when comets return, and a hundred other things. He must adorn it with physical significance, so he calls the left-hand side the rate of change of momentum and the right-hand side the force, and having called the right-hand side the force he naturally inquires, "Why should there be a force?" "Now," he says, "I will look for the reason for this force in some of the other things that I know about." And he thinks of a piece of elastic, and he sees how that exerts a force, and he wishes he could see that force which the planets exert on each other as arising in the same way as a piece of elastic exerts a force upon a stone which is fastened to one end of it when the stone is swung around in a circle with the other end of the elastic held in the hand. If I ask him why the elastic pulls, he will probably tell me that, while we do not know all about that, we believe that it is due to the fact that the elastic is composed of a lot of little molecules, and when they are separated from each other they tend to come back again. But I proceed to inquire why they tend to come back again when they are separated from each other. He tells me, "Well, although we say *separated,* we do not really mean separated. We believe that between the molecules there is a medium, and when this medium is stretched it tends to return to its original condition." But I inquire why it does this, and he tells me that it is because the medium is endowed with elastic properties. But I ask him what he means by that, and he tells me that it acts like a piece of elastic, and so I ask him why a piece of elastic pulls, and he tells me that it is because it is composed of a lot of little molecules, and so on, *ad infinitum.* You see all that even a successful appeal to the elastic could hope to do would be to show that this thing, gravitation, which we think we do not understand, acts in the same sort of way as that other thing about the elastic, which we also do not understand but think we do. There is a sort of a unification of ignorance in the matter; but this unification of ignorance is not something which should be despised—it is one of the plans and purposes of physics. Thus, we like to picture the atom working as a dynamo works, or as a motor works, or as the ripples on a bowl of water work—something which has become familiar to us in our youth and concerning which we have become accustomed to be satisfied. We met the elastic at an age when we were too young to question its actions, and when we had become old enough seriously to think about it, it had become so familiar to us that there seemed no necessity to think about it any further. The elastic was a little god, the origin of all things, who himself needed no explanation for his origin. And so physics, like everything else, has its starting point, its postulates, and the postulates of physics are its gods. Some appear artificial, as did the plain statement of the Newtonian law, and others mask in a guise of reasonableness, as did the elastic, but a reasonableness which very frequently evaporates in the sunshine of more complete thought.

In order that certain postulates shall be agreeable to a physicist of limited sophistication, it is necessary that they should be of the same kind as those associated with the behavior of circumstances and things to which the physicist has become accustomed and which he has been willing to accept on the basis of long acquaintance, formulated, probably, at a time before he had decided seriously to think about the matter. Then they must be associated with things which he calls "real." And what does he mean by the "reality" of things? We get a crude notion of his feeling in this matter by asking him to accompany us to a spiritualistic séance and seeing what he is willing to accept as to the reality of the ghost. It is not sufficient that the ghost has properties and produces phenomena. It is not sufficient, even, that the ghost shall produce material phenomena, such as the ringing of tambourines or the feeling of a draft. It is not sufficient that this entity, the ghost, shall merely be defined so as to account for all the phenomena that we are primarily interested in. It is necessary for his reality in the rather ill-defined accepted view of the matter that he shall have certain other properties which are not concerned with the activities which are the main purposes of his function. He must be capable of being seen; he must have weight; he must be felt when he is touched, etc. As a matter of fact, we should be more impressed with a ghost who had these properties and who did not do anything than we should be with one who was without them but was possessed in other respects of all sorts of remarkable powers. In our search for reality in physics, we do very much the same kind of thing. Bodies which are separated from each other appear to have effects upon each other. We discover the laws according to which these effects operate. We should like these laws to be interpretable in terms of a medium which we can think of as real. We shall be able to think of it as real if it has inertia and elasticity in the sense that a solid has inertia and elasticity, even though we have to take these properties as fundamental starting points in the case of the solid, and are unable to trace them to some ultimate source which of itself needs no explanation. At one end of our scale of satisfaction, we have a case where it is possible to account for the properties of the hypothetical medium without any departure whatsoever from the properties of the things that we have heard, smelled and felt, and ranging from this end of the scale to the other extreme end of complete expression in terms of abstract formulation, we have a graded sequence of possibilities which are apt to content us less and less, the further they are removed from the end of complete satisfaction. The other receives a slight blow to its prestige of reality when it is found that though it can operate according to inertia and elasticity, the elasticity is of a different type from anything that we happen to know of in the things that we have touched, seen, etc.

I have often been impressed by what I have sometimes called "the irrelevance of the obvious." I can illustrate the point by considering the case of a problem which I present to a small boy concerning a ball which is hurled vertically into the atmosphere with a certain speed. I ask him how long a period will elapse before it reaches its highest point. The boy comes back to me and tells me that he can not work out the problem, because I have not given him enough information. I ask him what information he would like to have, and he tells me that he would like to know the color of the ball. I tell him the color does not matter, but he probably does not like that, because some of the substantiality of the ball has vanished with its color. He asks for the weight of the ball, and I tell him that that does not matter. And I add that I will even withdraw my statement that it was a nice, round ball and will refuse to state what its shape actually is. Then, if he is materialistically minded, he will blow up entirely and demand how he is to work out the problem at all if I will not tell him anything about it. I finally tell him that the ball is red, that it weighs ten pounds, and that it is really a nice, round ball. He then goes to the blackboard, draws a circle, paints it red in his mind's eye, puts a "10" inside it, and works out the problem. When he brings up the result, I ask him where he utilized the redness of the ball. He looks through the calculations and finds that he did not use it. I ask him where the weight comes in. He looks through his calculations again and finds that he did not use that either, or if he did, it canceled out. And so with the roundness of the ball. Then I admonish him not to ask me a lot of unnecessary questions again. But I think I hear you sympathizing with this poor student. You will say to me, "What harm does it do to tell him that the ball is red, since the redness does not matter? Why did he sin in thinking that it weighed ten pounds, if, after all, its weight is irrelevant?" Well, I agree that in this case, perhaps, no particular harm was done; and yet I have a suspicion that if I allow him to think that the ball is red, some day he will come back to me with a problem which he is unable to solve, because, perchance, the ball in that problem may be blue. Then I shall have the trouble of bringing up past history to explain why it was that the redness of the ball really did not matter in the original problem. But if he has had this vision of redness for a sufficiently long time, it will have become so ingrained in his consciousness that he may be totally unable to think if he is deprived of it.

It would be very difficult to give a definition of what constitutes reality in a general sense which would satisfy everybody. For few who desire reality the greatest could state in words just what it is that they do desire. The best one could probably do would be to make a list of things and phenomena which he would agree were real. Then if one would take any of these things and gradually remove from it all the appendages which even our disciple of reality himself would admit were unnecessary for its function, it is probable that he would gradually find his conviction of reality vanishing with these appendages, until by the time that he had left all that he himself would claim were necessary, he would have something which, in terms of his own mode of thought, he would have to call "unreal." Even as the sight of the ghost, of his flowing robe, of his obvious weight, are the symbols of reality to the onlooker—though they perform no part of his function—so, frequently, in the physical world, those things which constitute that vague thought of reality are things which play no part in the phenomena which are the main interest of discussion. Sometimes, when systems and phenomena are of such an abstract nature as to shock our material senses, we even go to the extent of providing a curious kind of comfort for ourselves by garbing them in the very clothes of what constitutes reality to us, and then deny to those clothes themselves any of the ordinary properties of clothes, in order that they may not give any trouble. Thus, in the Bohr atom, we are apt to feel that we have something approaching reality in our model of electrons going around a nucleus in planetary orbits. We know that the laws according to which the electrons must operate are different from those of classical electrodynamics; but I think it safe to say that a great many physicists feel much happier in thinking of the Bohr picture than in thinking of the picture of wave mechanics, for example. And yet, what a curious situation we have here. In the Bohr atom, the only model that we have of anything is the model of the part that does not do anything. The Bohr theory gives us a beautiful picture of electrons moving in planetary orbits. The thing is delightful to look at on the blackboard; but, unfortunately, this beautiful model—what is going on on the blackboard—is just the part which is totally unobservable to our senses or in our apparatus. Only when the atom radiates do we get anything observable, but of the radiation mechanism the Bohr theory says nothing. It is true that by talking about the different states of the atom when it does not do anything we can set up a formal procedure for calculating what results follow when it does do something, but there is no picture of the process. In fact, everything which the picture would suggest in the matter of radiation is forbidden to happen. The planetary orbits are not a picture of the process any more than a conglomeration of railway stations presents pictures of the scenery on the journeys between them. A process of calculation we have, it is true; but, for the rest, it is simply a picture thrown in on the side to make us happy.

Let me cite a parable to indicate the condition of mind of one who thinks that in the Bohr atom he has a real, satisfying model. Suppose that I should encounter a strange monstrosity whom I was pleased to call a man, because he looks something like one. But suppose the monstrosity has all sorts of peculiarities. I look at him and exclaim, "See what muscles he has; such a being should be able to swing a five-hundred-pound hammer with ease. See how large his eyes are; such a being should be able to see the most distant stars without a telescope. See the length of his legs; such a man should have a stride which would carry him along at the rate of fifty miles an hour." And suppose that when we came to examine this being, we found that he could not lift a pepper pot, and that what he could lift in comparison with others of his kind depended not upon the size of his muscles, but upon the length of his hair multiplied by the diameter of his eyeballs. Suppose that his vision was no keener than ours, and such as it was, depended not upon his eyes at all but upon the distance between his toes divided by the diameter of one of his eyelashes. Suppose that his speed in walking depended not upon his legs but upon the length of his little finger. It might be that from his arms, legs, eyes, etc., we could make up a way of deducing what he would do under given circumstances, just as we can from the planetary orbits of the Bohr model make calculations about the radiation; but we should delude ourselves if we took comfort in thinking of this monstrosity as a man. And, if we take comfort from the resemblance between the pictures we draw from the Bohr atom and for the planets, we shall assuredly delude ourselves as to the significance of that resemblance also.

One who starts with certain preconceived pictures of how nature works may usually, with sufficient trouble, force those pictures to fit the frame of nature to some extent, but very likely there will be many loose joints and bizarre fits. If one takes two landscape paintings and superposes them by painting one over the other, he will get something which looks unlike any landscape. It is, of course, conceivable that by superposing a sufficiently large number of suitable landscapes, one might get something which looked like a circle, or a straight line, but to hold to the dogma that straight lines and circles are all fundamentally built up out of landscapes is to invite trouble.

If I should define the number of dimensions to be associated with a system as the number of numbers which it is necessary to assign to the system in order that, by writing down differential equations between them in terms of some arbitrary parameter, I could set up a satisfactory scheme of mathematics with a one-one correspondence to the facts of nature, it would probably be contended by many that I was talking in a very abstract manner and that such a definition of the number of dimensions of a system was highly artificial. The materialist will probably tell me that these dimensions are not real dimensions at all but merely mathematical abstractions. I shall ask him what he means by "real dimensions"—in what sense, for instance, does he regard space as three-dimensional? He will probably illustrate what he means by telling me that he sees me standing here, a three-dimensional being, with length, breadth and thickness, and that in this sense I have very obviously three dimensions. Alas! I shall have to point out to him that the impression which he gets of me is obtained through a two-dimensional image on the retinas of his eyes; that he sees me twice over, once in each eye; that he sees me upside down and that what the left eye sees the right-hand side of his brain interprets. The interpretation of the phenomenon of seeing your president here delivering this address is really a terribly complicated business.

Frequently, the development of a subject—such a subject as electrodynamics, for example, takes place in the first instance through experiments of a large-scaled nature performed upon more or less crude apparatus. As a result of this, we form concepts of a subject founded upon large-scale phenomena. We form concepts of electric and magnetic fields as the forces on magnetic poles and on unit charges. We form the concept of forces on the charges in the sense defined as the product of the masses associated with the bodies on which those charges exist, multiplied by their acceleration, etc. Later, as science develops, it becomes necessary to extend and generalize the mathematical equations which are the basis of the theory. They become generalized to apply to situations where the quantities cease to have meaning in the sense of their original definitions. There is no meaning to the field at a point inside an electron when defined as the force on a unit pole, nor, indeed, is there meaning to the force on the unit pole itself, even if we had it and could put it in the electron, when the force is defined as the mass of the pole multiplied by the acceleration. There arises a whole new formulation of the theory, in which these fields become defined in different ways in relation to a new set of starting points, etc. The things which were before the simple concepts, the masses of the bodies on which the charges were placed, now become quite complicated and elaborate parts of the theory. Those things which seemed to endow the subject with such elements of tangibility when considered on an engineering scale dissolve in meaning, leaving only the fundamental concepts which, as a matter of fact, were the only things which really counted in the engineering problems themselves, where, however, they remained hidden in the glittering robes of a spurious reality. And so, to the critically minded, there appears a reality in the new artificiality and an artificiality in the old reality. The process of generalization is not apt to become one in which the new forms a complication or extension of the old, but rather one in which the old is a rather vague, somewhat incomplete and illogical application of the principles of the new. When, as the result of a merciless stripping of irrelevant adornment from the laws of physics, we arrive at a spectacle unpalatable to the intellectual taste, let us ask ourselves whether this cold remnant does not contain the whole essence of the laws in the sense in which they are actually used. There is no harm in stimulating our intellectual activities by adorning our thoughts with irrelevant appendages, provided we use these appendages as our servants and not as our masters. It is true that the human mind is a mechanism which requires a spark to set it off. The mere assurance that it has all the necessary wherewithal to think with is not of itself sufficient to set the thinking going. If one man finds that a glass of wine is good for his mental activity, let him take it. If another finds that a model accelerates his thoughts, let him use it, however illogical and fantastic it may be, so long as he uses it only as a stimulant to thought and does not impose upon the structure which he has created some of the requirements of the model itself which may be inconsistent with the fundamentals of that structure. It is in the trouble caused by the requirements of these irrelevant characteristics of the model that the danger of an artificially created reality lies. Thus, in pondering upon the physical nature of an ether, for example, while we would strenuously deny that our picture of the all-prevading medium was anything like that of water, many of us will supplement the cold statement of the properties of the medium with vague shadows of substantiality, concerning which only the most dire intellectual torments would bring us to confess, even to ourselves, that we were semi-consciously thinking of the taste of ether, of the smell of ether, of its boiling point, etc.

I have spoken of a theory in mathematical physics as comprising the formulation of a branch of mathematics in which there is a one-one correspondence between the essential elements in the mathematics and the observable phenomena of nature. One of the main differences between the materialistic forms of theory and the more abstract forms is that in the former we seek this one-one correspondence between every stage of the mathematical work and some phenomena of the observable kind, while in the latter form of theory the correspondence only exists between the mathematics and nature at certain isolated points. I may perhaps illustrate this matter in a very simple way as follows. Suppose that a mathematician wants to write the equation of a parabola in what he calls the parametric form. He writes:

$$x = us, \tag{1}$$

$$y = \tfrac{1}{2}gs^2. \tag{2}$$

We then know that by eliminating s from these two equations, we can obtain the result,

$$y = \frac{g}{2u^2}x^2,$$

which is the equation of a parabola. But, for some purposes, it is convenient to leave the equation in a parametric form as expressed by (1) and (2). Now, if the physicist were presented with equations (1) and (2), he would ask what s was. The mathematician would tell him that s was nothing in particular, but simply an intermediate symbol, introduced for the convenience in relating x and y. But the physicist would be very unhappy about this. He would want a correspondence between this symbol s and something in nature. Happily, in this case, he has it. If he changes s to t, he can think of the whole problem as one of a falling body initially projected horizontally in the horizontal direction x with a velocity u, so that x equals ut, and allowed to fall vertically with an acceleration g, so that $y = \frac{1}{2}gt^2$. It is not always possible in physics to do what was done for s in this case, namely, to find a real correspondence between every symbol in the mathematics and some similar measurable quantity in the physics. At least, it is not possible to find it in a direct way. One can usually express one of the abstract quantities itself in terms of some of the measurable things in such a way as to evaluate it, but this usually does not satisfy the materialist. He likes to have the meaning of the quantity staring him in the face. Most of the quantities which cause trouble in mathematical physics, because of their abstract nature, may really be regarded, in a sense, as parameters in the equations—parameters introduced for the convenience of expressing the relationship between the observable quantities in a more convenient form than by some direct relationship. Considering, for example, the case of electrodynamics, it would be perfectly possible, but extremely cumbersome to express the motion of one electron as a function of the positions and motions of all the other electrons. The whole scheme of relationships assumes a much more elegant and convenient form when intermediate quantities called electric and magnetic fields are introduced as intermediaries. The electric and magnetic fields are really defined by the circuital relations in terms of the motions of the entities themselves; and then, by additional equations, those motions are again expressed in terms of the fields, the whole process being the equivalent of expressing the motion of the electrons in terms of each other.

If you should wish to force me to say what I would deem to constitute reality in a theory or in the conceptions which form a part of a theory, if you should demand of me a statement as to whether the concepts involved in a certain theory were real or artificial, it would, first of all, be necessary for me to ask for a precise definition of reality. I surmise that you will have difficulty in giving such a definition. Or, if you gave one which was satisfactory to yourself, I doubt whether it would be satisfactory to every one else. We should all probably find ourselves in the position of the group of statesmen who were discussing what Mr. Balfour meant when, at the time when tariff reform was a very touchy matter, he had ventured one of his customary non-committal phrases concerned with what he called "broadening the basis of taxation." Every one wanted to know what it meant and how it affected his own particular interests. A cartoon represents Politician A asking B what he understands by Mr. Balfour's statement, "broadening of the basis of taxation." B says, "Well, I mean exactly what Mr. C means." So they go to Mr. C, who says, "Well, I mean just what Mr. D means." Finally, they go to Mr. Balfour, who gives another of his famous statements: "Well, I mean exactly what we all mean." One might make definitions galore. He might define a quantity as real, provided that it obeyed the equation of continuity. He would then be comforted for the moment by thinking of a gas and would say, "Ah! My quantity now behaves just like a gas. If the amount that goes out of the room is greater than the amount that comes in, then the quantity in the room must decrease by an amount equal to the difference. Such stuff is really real. He tells that to the high-school boy who is quite satisfied about it until he is told that momentum also obeys the same relation. He is not so happy about the reality of momentum. We tell him that he will feel that that is also real when he gets older. We, at any rate, glory in a sophistication where momentum satisfies our mathematical criterion of reality and also our undefined sense of the fitness of things. Then the specialist in wave mechanics comes along with the mysterious quantity $\psi\psi^*$, concerning which he also has an equation of continuity. He may wish to present this quantity as a candidate for reality, but the materialist feels that he has been caught and that the claim is not fair. The wave-mechanical person demands to know why the claim is not fair. The materialist fishes around a bit and then thinks that he sees why the claim was not fair. He says, "You can not measure $\psi\psi^*$, whereas I can measure the density of a gas." But the wave-mechanical person contends that he can measure $\psi\psi^*$. It is a quantity which he can express in terms of the probability of the existence of an electron at a certain place. The materialist claims that this isn't any sort of a quantity at all—nothing like as tangible a quantity as is density. But, after all, if I ask him what is meant by density, he will probably tell me, "it is the mass per unit volume." Then I must ask what the mass is. If he defines mass by a momentum specification in which the measure of the mass is obtained through the velocity that it imparts to a standard of mass when it collides with it with an assigned velocity, then I begin to doubt whether the quantity "mass" is any less mysterious than the one called $\psi\psi^*$. On the other hand, if he defines it in terms of the weight, he has to rely upon a comparison with another body made through the agency of the mysterious force of gravitation, in order that he shall be able to say what he means by the mass. Of course, I am quite well aware of the fact that he has in his mind that high-school-text-book definition of mass as the quantity of matter in a body, but I fear that he would be hard put to it if I demanded an explanation of what he meant by "the quantity of matter," apart from such rather abstract definitions as I have cited. But perhaps our materialist, having been driven into a tight corner in the matter of the mass or in the matter of the density, will return to the conflict on the basis of the velocity. He will say, "for an equation of continuity, you need a velocity, but what on earth can be the velocity of the quantity $\psi\psi^*$?"[2] I tell him that in the wave-mechanical theory this quantity is defined in a certain way in terms of $\psi\psi^*$, and in a way, moreover, calculated to insure that the equation of continuity shall hold, the only element which finally remains as proved by the properties of the $\psi\psi^*$ function itself being the fact that the space integral of it throughout all space is constant with the time. I point out to the materialist that whenever I have a condition of that kind I can always associate with the quantity, in this case $\psi\psi^*$, a velocity u such that

$$\operatorname{div} \psi\psi^* u + \frac{\partial \psi\psi^*}{\partial t} = 0$$

holds throughout all space and does not require an influx through the infinite boundary to keep matters in order. "Ha, ha!" says the materialist. "Now I have caught you. Your equation of continuity was a bluff. You merely painted this $\psi\psi^*$ in the colors of reality by providing it with a meaningless velocity which enabled it to masquerade as something moving about and retaining its identity on the way. The materialist will claim that the velocity of a gas falls in a very different category. He points out that those little particles of gas are moving about in such a way that he can think of actually measuring their velocity with a meter stick. I could quarrel with him on this basis if I chose. However, I have plenty of ammunition in my pocket and will allow him this much rope; but I must ask him whether he really limits his idea of the equation of continuity as applicable only to situations of this kind. If he is old enough, he will probably remember the days when there were no electrons, at least in the minds of the physicists. He will remember the days when people used to think in terms of homogeneous distributions of electricity moving about in space or in conductors. I ask him whether he ever pondered upon the significance of the velocity of a homogeneous distribution of electricity or of anything else for that matter. I think he will have to confess to me that he did, but if he did, what was he really thinking about when he spoke of the velocity? He will probably ask me to picture one of the particles of the electricity and talk about that. However, I join with him in refusing to admit that there are any particles to talk about. Then he will probably ask me to imagine a little piece of cork placed in the homogeneous distribution of electricity, I confess that I find difficulty in this. However, if he forces me to do so or to let him do so, and talks about the velocity of that piece of cork, I shall never allow him to depart from his definition, and he will have to carry the velocities of corks with him for the rest of his life in all his discussions about electrodynamics. I shall never be willing to let him dissolve that cork and lead me to the stage of deceiving myself that I understand what is meant by the velocity of the electricity at the point at which it disappears. Finally, when the materialist has exhausted himself with his corks, etc., I shall ask him whether in the sense in which he thinks of velocity, the velocity really came in at all in his calculations about electrodynamics in those pre-electron days. He will say, "Certainly, it did! Consider, for example, the equation

$$\frac{1}{c}\left(\rho u + \frac{\partial E}{\partial t}\right) = \operatorname{curl} H. \qquad (3)$$

I ask him whether by any conceivable process he could arrive at the velocity used. He may see the equation of continuity staring him in the face and be tempted to use it, but after our discussion of a little while ago, in which he accused me of doing the same thing, he will not have the face to do that. It will probably occur to him that it is necessary, first of all, to come to a conclusion as to whether he knows what he means by E and H. Well, in those days of macroscopic phenomena, I will allow him to use his unit poles and unit charges for the purpose of talking about E and H. Then, I think, he will have to confess to me that in order to get the quantity u, he will have to get, first of all, the current density, which is the quantity that he is going to regard as the product of ρ into the unknown velocity of u, and he will have to get this current density through equation (3) or its equivalent. As a matter of fact, limiting ourselves to the case of steady currents we all know that when we measure a current we are apt to use a tangent galvanometer and measure it by the magnetic field which it produces, which process is the equivalent of our measuring it by this equation (3) for the particular case where the conditions are steady. Then, having obtained this current density, it will be necessary for him to get the charge density. He will then have to get the charge density by a process which is the equivalent of defining that density through the equation $\rho = \text{div } E$. We are confining our attention to the case where only one kind of electricity is involved. If his picture of the phenomenon is one where there are positive and negative densities moving in different directions, then the argument requires elaboration, but what I have said about it so far is sufficient to indicate the principle which I wish to enforce, namely, that in the sense in which even our materialist would be driven to define his density and his velocity, these qualities would depart very greatly from the concepts which he thought he was thinking about when he thought of the density and velocity of a gas. They would, in fact, involve, in their definition, a degree of what he would call "abstractness" which was in every way comparable with the abstractness involved in the definition of similar quantities in the case of wave mechanics, for example. The difference between the two lies not in the subject, but in the materialist himself. When he thought he was thinking about the electricity, he really was thinking about a gas or water. As the result of this mental stimulation, he was encouraged to carry out the analytical processes permitted by his mathematical equations, with the confidence that he knew what he was doing as he went along. This concept inspired him to make many steps and do many things which he ought to have based on purely analytical procedure, but in which he short-circuited much mathematics by using his intuition. In the case where he was dealing, let us say, with a charge distribution of limited extent which, in his language, was in motion, he has no difficulty in making the calculations necessary to find the time that it takes to go from the point A to the point B. He divides the element of distance ds by the velocity u and integrates. However, he should have been much more careful about this procedure. He ought really to have investigated through his electromagnetic equations the story of the gradual disappearance of the density in one place and its appearance in another, or, at any rate, if he did use the concept of a velocity, he ought to have used it in the sense in which we have conceived of it as being defined.[3] But he does no such thing; he uses his intuition and gets a simple solution to the problem. He, as it were, writes a check based on what he thinks is the intuitional balance of his account in his brain, but it is because of the strength and consistency of his mathematical securities that the check becomes honored. In the whole realm of a mathematically consistent structure, we may think of a multitude of cases which represent conclusions of value. These are linked by paths—sometimes tortuous to follow—of logical reasoning. If we take a lot of different mathematical structures, we shall find that many of the "stations of conclusions" look alike and the railroads that run between them have great similarity. In certain of these mathematical structures, the mind has become so familiar with the relationship of the stations that it can jump from one to the other with alacrity. The jump is philosophically hazardous. It is nearly always right, but the mind little realizes the chances that it has to take. When a similar set of stations makes its appearance in some other mathematical structure, and when the mathematical "railroads of logical thought connections" are the same, our materialist can still jump from one to the other with perfect security. He may be more frightened in his jump, so that in fact he has no confidence to jump at all, because he may be under the illusion that when he jumped before he jumped for certain reasons inherent in what he regarded as the physical significance of the things he was talking about, whereas the only thing which really justified his jump was the mathematical railroad which he had discarded. If he can delude himself with a sufficiently large dose of reality to have confidence to jump in the new realm, he will again avoid breaking his neck, but not for the reasons which he thinks are guiding him, but again on account of the guardian angel in the shape of the mathematical substratum which guards his intellectual adventures. Most of us stimulate our brains to action by the vision of an ill-defined reality at the back of our mental processes. So long as we treat it as a means to an end, all is well, but for him who thinks it has fundamental significance apart from the logical scheme of laws which represent the story to be told, there is trouble ahead. For you who seek reality as something characteristic of certain concepts in physics as distinct from others will find that such reality is but a will-o'-the-wisp of philosophy. You may think you have it in your hand but will find that you have merely the shadow of something else. You will pursue that something else; you will touch it, and again it will feel real until you find that your consciousness of its touch is no more than the tingle of your own blood as your hands clasp upon it. Reality is the most alluring of all courtesans, for she makes herself what you would have her at the moment; but she is no rock on which to anchor your soul, for her substance is of the stuff of shadows; she has no existence outside your own dreams and is often no more than the reflection of your own thoughts shining upon the face of nature.

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[2] For simplicity, we confine our attention to a three-dimensional case.

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[3] Complicated now to an even greater extent by the inclusion of the $\frac{\partial E}{\partial t}$ term of Maxwell in equation (3).

THE CHANGING BACTERIA[1]

By Professor C.-E. A. WINSLOW

DEPARTMENT OF PUBLIC HEALTH, YALE SCHOOL OF MEDICINE

I HAVE been asked to sum up the discussion on bacterial variability to which we have listened this morning chiefly as a compliment to my years, because I have lived through more radical changes in our concept of the bacterial cell than have fallen within the lifetime of many of those present. I am here in the capacity of the innocent bystander, as a witness to the assault which the younger generation of bacteriologists are making on the concepts which in the past were held most sacred.

I happen to have been born in the year 1877, the year in which Nägeli published his famous book emphasizing his concept of pleomorphism, which assumed an almost unlimited variability, involving mutual transmutations between bacteria of the most widely separated groups. His extreme position was quickly overthrown by the work of Koch, Cohn and Migula and their followers, and for a period of thirty years bacteriology was ruled by the concept of relatively fixed and simple bacterial types.

We did know all along that certain variations occurred in the physiological reactions of bacteria, but these variations were for the most part closely and directly related to environmental conditions. We knew, for example, that *Bacillus prodigiosus* produces no red pigment at 37°. We knew that the virulence of many organisms could be enhanced by passage through suitable animal hosts. We knew, too, that virulence could be attenuated by exposure to unfavorable environmental conditions, as in the production of anthrax vaccine by Pasteur. Such variations as this, however, variations which were held to be gradual in their development, quantitative in nature and directly dependent upon the maintenance of the environment which called them forth, did not materially disturb our concepts of bacterial stability.

The first real threat to the older ideas was in the work of Neisser (1906) and Massini (1907) upon *B. coli-mutabile* and in the simultaneous work of Twort on the acquisition of new fermentative powers by organisms of the colon-typhoid group. These observations were confirmed but still regarded as representing exceptional phenomena. Twort's work was, however, continued and broadened by Penfold and elaborated by Ledingham in England, while Eisenberg in Germany was bringing forward convincing evidence of new types of bacterial variability. In 1917, came the work of Weil and Felix on Proteus X 19, in 1921, the recognition of rough and smooth forms by Arkwright; and very shortly the universality of the phenomenon of bacterial dissociation was demonstrated beyond any question. No one can read Hadley's magnificent monograph on this subject without being convinced that we are dealing here with a wide-spread and fundamental characteristic of the bacterial cell.

It is an extraordinary evidence of the fact that we see with our minds and not our eyes that this phenomenon should have remained so long undiscovered. For thirty years, bacteriologists had had rough and smooth colonies staring them in the face and had refused to see them because they did not fit into preconceived concepts of what should be there.

It is now at any rate clear that bacteria of very widely separated groups in pure line cultures, sometimes cultivated from a single cell, break up into two or more different strains with characteristics clearly differentiating them from each other. These characteristics may manifest themselves in cell morphology and capsule formation, in colony type, in biochemical characters and in virulence. The variants may breed true for generations, but in a vast majority of instances they tend in whole or in part to revert to the parent type or to change from one type to another, if suitable environmental stimuli are provided. There is no wild or random variation, for certain fundamental characteristics remain constant and the behavior of a rough or a smooth dissociant of a given species may be just as characteristic as that of the parent strain from which it was derived. The process is not one of mutation in the ordinary biological sense, since it is generally reversible and a true mutation is not. Dissociation is also markedly influenced both in amount and in direction by environmental factors. Yet the relation is in no sense direct and specific, as is the case with impressed variations. On a single culture plate, with essentially uniform environmental conditions, we find colonies of various dissociation types growing side by side. Furthermore, dissociation differs from the phenomena of impressed variation in the fact that it is relatively discontinuous, giving us 2, 3 or 4 well-defined strains which are usually much more common than are intermediate forms. (In certain instances, as in Marshall and Jared's recent work on Brucella, the shift from S to R forms fails to show such discontinuity). Finally, in widely separated groups of bacteria, dissociation seems to operate on general parallel lines, as evidenced by the fact that we can apply such terms as "rough" and "smooth" to the resulting strains.

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[1] Address delivered before the Society of American Bacteriologists, Baltimore, December 28, 1931.

Hadley lists the characteristics of the smooth form as follows, those of the rough form being generally the opposite:

R, Mutant Type

- Agglutinative growth in broth.
- Sedimentary suspension in 0.8 per cent. salt sol.
- Often expansive growth on agar.[2]
- Colonies rough, irregular, flat.
- Seldom generates secondary colonies.
- Agar growth harder, translucent.
- Agar growth seldom so fluorescent.
- Agar growth nonpyocyanogenic.
- In motile species, nonmotile.
- Noncapsulated.
- Biochemically less active.
- Often pure R; may have some O or S.
- Lacks the "specific soluble substances."
- Flocculent precipitate only in immune serum.
- Slightly or nonvirulent (nontoxic[3]).
- More common in carriers and convalesc.
- More common in chronic infections.
- More resistant in aging.
- Less sensitive to bacteriophage.
- Product of adaptations.
- Tendency to short rods and cocci.
- Not transformed in S immune serum.
- Transformed to S in R immune serum.[4]
- Susceptible to phagocytosis.

In general the smooth strain is the more virulent one; although with the cocci this relationship is reversed; and in general there is a tendency for the less virulent form to predominate, after cultivation outside the animal body.

Meanwhile, the concept of the simplicity of the bacterial life cycle has been upset during the past fifteen years by evidence of an entirely different kind. It had been known from the earliest days of the science that many bacteria went through a spore stage as a part of their life cycle; but this was the only exception to the general rule of binary fission. In 1916, however, Hort in England demonstrated the formation of gonidial bodies forming a definite reproductive stage in the life of colon-typhoid organisms. In the same year Löhnis and Smith in the United States and Enderlein in Germany described a whole life cycle involving complexities like those characteristic of certain of the higher fungi; and more recently it has been demonstrated that bacteria of widely separated groups may pass through a filterable stage which is later able to reproduce the original type of cell from which it was derived. The phenomena of gonidia formation and of filterability are now established beyond any question; and such work as that of Morton Kahn, in which the entire process of cell-disintegration and reintegration has been observed under the microscope in single-cell cultures, should convince the most skeptical. Evidence for a form of sexual reproduction in certain bacteria is also impressive, if not completely conclusive. Kuhn and Sternberg have recently attempted to explain all the phenomena of bacterial variation as due to the presence and influence of new hypothetical protozoon-like organisms which they call Pettenkofer bodies; but their assumptions seem wholly gratuitous.

Hadley and others believe that the two sorts of phenomena which have been here discussed are fundamentally related and that dissociation is the result of sexual reproduction. I must confess that I am not yet convinced of any such essential relationship and I believe it is wiser at present to recognize two distinct types of bacterial variation, which we may for convenience call dissociative and cyclogenic, and to leave the question of their interrelationship open for further exploration.

I must confess that it is not easy to distinguish clearly and sharply between these two phenomena on philosophical grounds. Both represent essentially discontinuous and reversible changes in morphological and physiological characteristics. Both are influenced by the environment; yet one senses a certain fundamental difference between the two types of variation. The cyclogenic variation, as its name implies, suggests an analogy with the normal life cycle of the higher forms of life, while dissociation similarly recalls mutation in the higher forms. As stated above, however, this latter analogy can not be a true one because of the reversibility of dissociation phenomena and also because discontinuity in dissociation is only relative. For the present we can perhaps only recognize the two distinct types of variation and hope for further light as to their significance and mutual relationship. I do not, however, believe that more than two new types of variability need not at present be postulated; and I would suggest that efforts be made to correlate any fresh phenomenon of variation with either the cyclogenic or the dissociative type of variability, before introducing new terminology or new philosophical concepts.

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[2] Apparent exception in case of *B. proteus.*

[3] Relation to toxicity established only for *B. diphtheriae* and *B. enteritidis;* suggested for *B. dysenteriae* Shiga and for *B. botulinus.*

[4] Established for *B. subtilis.*

Bacteriophagy I conceive as a third and quite distinct phenomenon, arising from the influence upon bacteria of a self-perpetuating substance (probably an organism) of independent origin. I can not believe with Hadley that bacteriophage is a result of dissociation; nor can I agree with my colleague, D'Herelle, that dissociation is necessarily and always a result of bacteriophagy. Rough strains are commonly lysogenic and a symbiosis between bacterium and bacteriophage might explain the appearance of certain "rough" characteristics. It seems quite certain, moreover, that action of bacteriophage is one of the commonest and most powerful stimulants to both cyclogenic and dissociative variation. It may well be, however, that other incitants would prove to be of equal generality if they were tested as extensively.

As one who has been long interested in systematic bacteriology I would point out that all this new knowledge does not involve a return to Nägeli's pleomorphism nor does it invalidate the conception of bacterial specificity. The fact that under certain conditions the colony of typhoid bacilli produces papillae of lactose-fermenting organisms is just as definite a characteristic of the typhoid bacillus as the fact that most of its cells fail to ferment that sugar. What we are getting from these studies is not a negation of bacterial specificity, but a conception that the characteristics of each species are vastly more complex than we had supposed.

Nor is there any danger that these new discoveries will overthrow the fundamental bases of epidemiology. It is just as true as it ever was that typhoid fever is normally caused by the presence of the Eberth bacillus and diphtheria by the Klebs-Loeffler bacillus. The simple concepts of specificity have proved their value. They are relatively, if not absolutely, sound, as proven by the empirical results obtained through their application. On the other hand, the new knowledge opens enormous possibilities of explaining obscure phenomena and of obtaining new methods of defense against communicable disease. The serological relation of Proteus X 19 to typhus fever and of *Salmonella suipestifer* to hog cholera, the association of Pfeiffer bacilli and streptococci with influenza and poliomyelitis may all perhaps be elucidated by future discoveries in this field. It may be that exposure to a non-virulent but immunizing phase of the diphtheria bacillus and the streptococcus may account for the development of immunity which takes place during childhood and which always seemed a difficult phenomenon to explain on accepted principles. The use of nonvirulent dissociants like the bacillus of Calmette and Guerin may widen our resources in the production of artificial immunity.

The brilliant work of those who have presented papers to-day, and of their predecessors, has opened up new fields in bacteriology which are full of hope and promise. They have given us a new concept of the marvelous properties of the organisms with which we work. They have multiplied the fascination and the practical possibilities of our science.

SCIENTIFIC EVENTS

THE ANNUAL EXHIBIT OF THE BRITISH PHYSICAL AND OPTICAL SOCIETIES

THE twenty-second annual exhibition held jointly by the Physical Society and the Optical Society was held at the Imperial College of Science and Technology, South Kensington, in January. The exhibit was open to the general public. The London *Times* reports that the bulk of the floor space was occupied by the exhibits, many of them new, of the firms of scientific instrument makers. On the top floor and at a few other stands, however, there may be seen groups of apparatus displayed by some thirty contributors to the Research and Experimental Section.

The exhibitors here include many official bodies, such as the Meteorological Office, the Government Laboratory, and the National Physical Laboratory, the last of which showed a great variety of apparatus, including an interesting optical test of the effects of glare on the eye. The Post Office Engineering Research Station showed, among other apparatus, an "artificial ear," which has acoustic effects upon a telephone receiver equivalent to application to a human ear.

Mr. R. G. Bateson, of the Forest Products Research Laboratory, exhibited a direct-reading humidity meter operating on the wet and dry bulb thermometer principle, and enabling calculations of humidity to be made by inspection without reference to the usual tables or charts. A new humidity control apparatus for use in small testing rooms and laboratories was shown by the Wool Industries Research Association, together with a meter for testing the permeability of fabrics by the air, an extensometer for testing the elasticity of individual fibers, and a combined electrical heater and temperature measuring sheet which will enable cloth-pressing to be carried on by less empirical methods than at present. The Rothamsted Experimental Station displayed a "pachimeter" made out of meccano parts for testing the plasticity of soils and clays. This, it is thought, may be useful also for millers and bakers in the preparation of flours.

Apparatus for studying speech visually were to be seen in many parts of the exhibition, the most interesting, perhaps, according to the *Times*, being that developed by Professor E. W. Scripture and the adaptations used at the Speech Laboratory of the West End Hospital for Nervous Diseases by Miss F. Janvrin. Speech curves, it appears, can be produced upon smoked paper, so as to provide clearly recognizable tests for the presence of such diseases as epilepsy, disseminated sclerosis, or general paralysis when the symptoms can not be directly recognized in listening to the patient's voice. Another interesting application of physical apparatus to physiological problems was shown by Professor A. V. Hill, in photographic exhibits of the minute heat-production curves which are produced by the stimulation of a nerve or the twitch of a muscle.

In the trade section the experimental sound-film projector for sub-standard (16 millimeter) film shown by the Ensign Company, the "tong-test" for alternating and direct current measurement produced by Crompton Parkinson, and the giant epidiascope with a throw of 70 feet made by W. Edwards and Company were typical of the more popular apparatus.

THE FEDERAL APPROPRIATIONS FOR AGRICULTURAL RESEARCH

SCIENCE SERVICE reports that items in the agricultural appropriation bill, which were reduced below the Bureau of the Budget estimates for 1933 by the House Committee on Appropriations included many lines of scientific research, which had already felt the pruning knife of the agricultural chiefs and the bureau.

The Bureau of the Budget estimates had pared the $235,064,694 agricultural supply act of 1932 down to $186,243,405—a decrease of more than $60,000,000. Much of this was concerned with decreased appropriations for road building and relief loans—in fact almost all of it except about $10,000,000 to be cut from regular departmental activities. Actual savings of more than three millions, to revert to the treasury, were planned in various agricultural bureaus.

The house appropriations committee cuts from budget estimates, amounting to an additional ten million dollars, were made all along the line, and touched the following scientific investigations:

Administration of agricultural experiment stations, $13,646. (Bureau of the Budget had recommended increase.)

General weather service and research in Weather Bureau, $30,500. (Already cut $71,482.)

Aerology, $26,900. (Already cut $225,000.)

Animal husbandry, $20,505. (Already cut $29,495.)

Diseases of animals, $6,000. (Already cut $31,050.)

Dairy investigations, $9,900. (Already cut $69,442.)

Barberry eradication, $3,600. (Already cut $177,140.)

Cereal crops and diseases, $3,700. (Already cut $19,575.)

Citrus canker eradication, $2,100. (Already cut $7,900.)

Cotton production and diseases, $2,600. (Already cut $12,100.)

Rubber, fiber and other tropical plants, $1,500. (Already cut $25,031.)

Protection and administration, national forests, $76,500. (Already cut $119,746.)

Forest products investigations, $2,200. (Already cut $25,460.)

Agricultural chemical investigations, $5,600. (Already cut $5,851.)

Color investigations, $800. (Already cut $2,500.)

Insecticide and fungicide investigations, $1,100. (Already cut $10,000.)

Soil chemical and physical investigations, $200. (Already cut $30.)

Cereal and forage insects, $4,900. (Already cut $42,500.)

Insects affecting man and animals, $4,300. (Already cut $10,200.)

Agricultural engineering investigations, $6,600. (Already cut $58,550.)

Home economics investigations, $900. (Already cut $12,335.)

Pink boll worm control, $5,600. (Already cut $61,000.)

Gypsy and brown-tail moth control, $5,700. (Already cut $65,000.)

European corn borer control, $500,000. (Already cut $155,000.)

Japanese beetle control, $25,000. (Already cut $45,000.)

Among other cuts made by the Bureau of the Budget and not touched by the committee was one of $40,840 from the soil erosion investigation appropriation last year.

THE INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY

THE Ninth International Congress of Pure and Applied Chemistry will be held in Madrid from April 3 to 10. The officers of the congress are: J. R. Mourelo, vice-president of the Academy of Sciences and professor emeritus of the School of Arts, *honorary president;* O. Fernandez, professor at the University of Madrid, member of the Academy of Sciences and dean of the Academy of Pharmacy, *president;* and E. Moles, professor at the university and at the

National Institute of Chemistry and Physics and president of the Spanish Society of Chemistry and Physics, *general secretary.*

The city of Madrid is of interest as a scientific and art center and during the week of the congress Spanish cities, including Seville and Granada, are holding festivals and religious ceremonies and the Andalusia fairs that many members will wish to attend will be in progress. It has therefore been decided to confine the congress to three days, leaving three days during which the meetings of the ninth conference of the International Union may be attended and one day devoted wholly to excursions.

The provisional program follows:

Sunday, April 3

6: 30 P. M. Reception of delegates and families by organizing committee.

Monday, April 4

10 A. M. Congress opens.

11 A. M. to 1 P. M. General lecture on "The Raman Effect in Connection with Chemical Constitution," followed by discussion. Sir R. V. Raman, K. W. F. Kohlrausch, and J. Cabannes.

4 to 6 P. M. Meeting of groups and sections. Presentation and discussion of reports.

Tuesday, April 5

Morning left free.

6: 30 P. M. Reception.

Wednesday, April 6

9: 30 A. M. to 1 P. M. General lecture on "The High Polymers in Chemistry," followed by discussion. K. H. Meyer, A. Staudinger, and W. Bragg.

3: 30 to 6 P. M. Meeting of groups and sections.

6: 30 P. M. Reception.

Thursday, April 7

Reserved for excursions.

Friday, April 8

9: 30 A. M. to 1 P. M. General lecture on "The Chemistry of High Temperatures," followed by discussion. C. Matignon, O. Ruff, and A. Day.

4 P. M. First meeting of council of International Union of Chemistry.

4 to 6 P. M. Meeting of groups and sections.

9 P. M. Official dinner for members of congress.

Saturday, April 9

10 A. M. Meeting of council of International Union of Chemistry.

10 A. M. to 12 M. Meeting of sections and drafting of conclusions.

4 P. M. Closing session.

5 P. M. General assembly of International Union of Chemistry.

Sunday, April 10

Reserved for trips.

The organizing committee has issued a bulletin which includes an account of events leading to the invitation to meet in Madrid. This statement is in part as follows:

> In April of 1928, at the celebration of the twenty-fifth anniversary of the Spanish Society of Chemistry and Physics, the president of the society, Professor Palacios, interpreting the heartfelt desire of all Spanish chemists, placed before the King, Alfonso, who was presiding at the function, the plea that he would authorize the delegates of Spain in the International Union of Chemistry to petition that the ninth gathering should be held in Madrid, and, that on the occasion of this meeting, the first post-war congress should take place. This would be the ninth of those held up to the present and would undoubtedly prove to be the best possible means of strengthening the friendly relations among the chemists all over the world. The petition met with a most favorable reception.
>
> In response to this proposal, at the conference which was held at The Hague in July of 1928, by the International Union of Chemistry, the delegation from Spain then present drew up the invitation, which was unanimously accepted.
>
> In view of this agreement, the National Council of the Spanish Federation of Chemical Societies, a Spanish Organization Affiliated to the Union and Comprising the Delegations of the Spanish Society of Chemistry and Physics, of the Society of Spanish Mining Engineers, of the National Union of Chemical Experts, of the Academy of Sciences, of the Institute of Oceanography, and of the National Chamber of Chemical Industries, at that time, negotiated and obtained from the public authorities of the country the entire approval which took the form of a solemn resolution of the government, with the inclusion of credits for the preparatory expenses of the congress in the general state budget of 1929.

AWARD TO DR. CHARLES H. HERTY

THE medal of the American Institute of Chemists has been awarded to Dr. Charles H. Herty.

This medal is awarded annually for "noteworthy and outstanding service to the science and profession of chemistry in America," and is given to Dr. Herty in recognition of his efforts over a long period of years on behalf of American chemists and the American chemical industry. Recently, Dr. Herty has aided the economic rehabilitation of the South by his researches on the paper pulp possibilities of the slash pine. This work is being perfected commercially in the new laboratory built for the State of Georgia by the Chemical Foundation.

In making announcement of the award Dr. Frederick E. Breithut, president of the institute, has issued the following statement in regard to the work of Dr. Herty:

> More than any other chemist, Dr. Herty has held to the ideal of making the United States chemically self-sufficient, dependent on no foreign nation for industrial and pharmaceutical necessities.
>
> Dr. Herty first made himself felt as an economic influence when his early researches at the University of Georgia revolutionized the turpentine and naval stores industry. The Herty method of collecting turpentine greatly increased the productiveness of the pines. Other discoveries corrected wasteful methods of turpentine orcharding and conserved the forests.
>
> Rising to national prominence, Dr. Herty served two years as president of the American Chemical Society, in the all-important years 1915–1916. It was he who awakened the chemists of the country to their national responsibility. He cooperated in mobilizing the chemical man-power of the country and in taking a chemical census which presented the national government with a detailed view of the chemical potentialities of the country.
>
> In 1917, as editor of the *Journal of Industrial and Engineering Chemistry*, he made that publication a guiding influence among American chemists. He began the policy of educating the people about chemistry, and helped form the Chemical Warfare Service as a separate branch of the army.
>
> When the war was over, Dr. Herty insisted that the United States remain chemically independent. He threw himself into the fight for a tariff law which would protect the American chemical industries and insure a supply of medicinals, dyes and other essential chemicals. In carrying on this fight he resigned his editorial position and became president of the Synthetic Organic Chemical Manufacturers' Association. Under the tariff act of 1922, the chemical industry in the United States has grown and prospered.
>
> Another act which furthered public welfare was Dr. Herty's effort in behalf of the Ransdell Bill, which established the National Institute of Health and made health research a direct activity of the federal government.
>
> In 1926 he became adviser to the Chemical Foundation and assisted the foundation's activities in aiding the American chemical industry and in educating the public to the importance of chemistry.
>
> All through Dr. Herty's career he has devoted himself to the welfare of chemists and of the country at large. It is particularly appropriate that we should present him the medal at this time, when his latest investigations, on the southern pines, are just reaching completion. If the South turns from cotton and makes its pines the basis of a new prosperity, that prosperity will be largely due to Dr. Herty.

In addition to Secretary Mellon and his brother, awarded last year the medal of the American Institute of Chemists for establishing the Mellon Institute, other past medalists are Mr. George Eastman, honored for his work in making fine organic chemicals available to the chemists of the country, and Mr. and Mrs. Francis P. Garvan, who established The Chemical Foundation.

The presentation of the medal to Dr. Herty will take place at the annual meeting of the institute, to be held in New York in May.

IN HONOR OF HERMAN LEROY FAIRCHILD

A BUST of Herman LeRoy Fairchild, professor emeritus of geology at the University of Rochester, was presented on January 14 to the university by the Rochester Academy of Science. To honor Dr. Fairchild and to celebrate the occasion, the Rochester Academy of Science and the Rochester Chapter of the Society of the Sigma Xi arranged a dinner and joint meeting at which the bust was unveiled by Dr. Fairchild's granddaughter, Miss Jean Kathryn Fairchild. Professor Floyd Fairbanks, president of the Rochester Academy, presided and the principal address was delivered by Professor Heinrich Ries, of Cornell University, on "The Industrial Value of Geology."

Praise bestowed with such feeling, as can be fully appreciated only by those in attendance, revealed the affection and esteem in which Dr. Fairchild is held by his former students, by his colleagues at the university, and by the members of the scientific societies which he helped to found. In presenting the bust, Professor Fairbanks told of Dr. Fairchild's service to the Rochester Academy of Science, in organizing it on its present basis in 1888, as president from 1889–1901, and as chairman of the publications committee. President Rush Rhees, of the University of Rochester, told of the enthusiasm and untiring energy exhibited by Dr. Fairchild toward both his teaching and his scientific studies since he came to Rochester in 1888. This was further attested by Dr. Harold L. Alling, a former student and now head of the department of geology. Dr. John R. Murlin, president of the local chapter of Sigma Xi, told of Dr. Fairchild's interest and influence in securing the charter for this chapter of which he is now honorary president. Before delivering his address, Dr. Ries spoke of the service Dr. Fairchild has rendered the Geological Society of America as one of the founders, as secretary for seventeen years, and later as president. Dr. Fairchild himself gave a short address.

Some of Dr. Fairchild's 236 publications were placed on exhibit next to the bust.—Q. D. S.

SCIENTIFIC NOTES AND NEWS

The William H. Nichols medal of the New York section of the American Chemical Society for 1932 has been awarded to Professor James Bryant Conant, chairman of the division of chemistry at Harvard University, in recognition of his work in organic chemistry, particularly in the chemistry of chlorophyll. Dr. Conant will be presented with the Chandler Medal of Columbia University on February 5, when he will discuss "Equilibria and Rates of Some Organic Reactions," and the Nichols Medal on March 11, when he will speak on "An Introduction to the Chlorophyll Molecule."

The honorary degree of doctor of science has been conferred by the University of Chicago on Dr. William Wallace Campbell, president emeritus of the University of California, president of the National Academy of Sciences.

The Royal Swedish Academy of Science has elected Professor R. W. Wood, of the Johns Hopkins University, a foreign member, in recognition of his researches in the domain of physical optics.

The William Wood Gerhard Gold Medal of the Pathological Society of Philadelphia was presented to Dr. Alfred N. Richards, professor of pharmacology, University of Pennsylvania School of Medicine, at a meeting on January 14. Dr. Richards addressed the meeting on "Recent Developments in the Experimental Study of the Function of the Kidney."

The Order "Al Merito" of Ecuador was recently presented to Surgeon General Hugh S. Cumming, director of the Pan American Sanitary Bureau, in recognition of the cooperation of the bureau with the Government of Ecuador in a sanitary campaign throughout the republic and especially in Guayaquil.

At the New Orleans meeting of the American Society of Naturalists officers were elected as follows: *President*, Dr. R. A. Gortner, professor of agricultural biochemistry, University of Minnesota; *Vice-president*, Dr. H. J. Muller, professor of zoology, University of Texas; *Secretary*, Dr. E. W. Lindstrom, professor of genetics, Iowa State College (3 years); *Treasurer*, Dr. Sewall Wright, professor of zoology, University of Chicago, reelected.

Dr. Winterton C. Curtis, professor of zoology, University of Missouri, has been elected president of the American Society of Zoologists.

Newly elected officers of the Botanical Society of America are: *President*, Dr. George J. Peirce, professor of botany and plant physiology, Stanford University; *Vice-president*, Dr. Arthur J. Eames, professor of botany, Cornell University; *Secretary*, Dr. Sam F. Trelease, professor of botany, Columbia University; editors of the *American Journal of Botany*, Dr. Lester W. Sharp, professor of botany, Cornell University, and Dr. B. M. Duggar, professor of physiological and applied botany, University of Wisconsin.

The council of the American Institute of Consulting Engineers has elected the following officers for the ensuing year: *President*, Mr. Charles Page Perin, of New York, to succeed Colonel Frederic A. Molitor; *Vice-president*, Mr. Edwin F. Wendt, of Washington, D. C., and *Secretary*, Mr. Philip W. Henry, of New York. Mr. J. P. Hallihan, of Detroit, and Mr. A. E. Forstall, of New York, are new members of the council.

Professor James B. Pollock, who for approximately thirty-five years has been a member of the department of botany of the University of Michigan, has presented his resignation, to take effect at the end of the present semester.

Dr. P. S. Burgess, professor of agricultural chemistry at the University of Arizona, has been appointed dean of the College of Agriculture and director of the Experiment Station.

Dr. Howard D. Newton, professor of chemistry, has been appointed dean of the Division of Arts and Sciences of Connecticut Agricultural College at Storrs He succeeds the late Professor George H. Lamson.

Dr. Mark V. Ziegler, of the U. S. Public Health Service, will spend a year in Raleigh, North Carolina, assisting the State Board of Health in the development of the state and county health programs.

Investigation of cosmic rays on mountain-tops in snow-water lakes and deep tunnels in Colorado will be resumed in June when Dr. R. D. Bennett, of Boston, will join Professor Joyce C. Stearns, of the University of Denver, and his party.

Dr. Saul B. Arenson, associate professor of chemistry at the University of Cincinnati, will sail early in April for a tour of the Orient and Australasia. He intends to investigate the status of the broadcasting of scientific talks, as well as to visit certain chemical industries in which he is interested.

Dr. Paul Weatherwax, of the department of botany of Indiana University, will leave New Orleans on February 17 for a three months' collecting trip in southern Mexico and Central America. A general collection of grasses will be made and special emphasis will be placed on material having any bearing on the question of the ancestry of Indian corn.

ROBERT VAN V. ANDERSON, formerly of the U. S. Geological Survey, is completing a two years' stay in Algeria where he is engaged in a geological study of the western coast ranges, as collaborator of the "Service de la Carte Géologique de l'Algérie." His address is care of the American Consul, Algiers.

THE first Arthur Lecture of the Smithsonian Institution will be delivered on January 27 in the Auditorium of the Natural History Museum, by Dr. Henry Norris Russell, professor of astronomy at Princeton University. His subject is "The Composition of the Sun."

THE Cutter Lecture on Preventive Medicine will be delivered by Dr. Leslie T. Webster, of the Rockefeller Institute for Medical Research, on Tuesday, January 26, at the Harvard Medical School. Dr. Webster will speak on "Experimental Epidemiology."

THE annual invitation lecture of the University of Iowa Chapter of Sigma Xi was given on January 13, by Dr. Edgar Allen, professor of anatomy and dean of the School of Medicine of the University of Missouri. The title was "Eggs of Man and Monkey." Following the lecture a series of demonstrations of research in progress in the department of zoology were available for inspection of the members and guests of the society.

DR. PHILIP B. HADLEY, associate professor of bacteriology at the University of Michigan Medical School, will give the Eighth Ludvig Hektoen Lecture of the Frank Billings Foundation at the City Club, Chicago, on March 25, on "New Trends in Medical Bacteriology and Immunology."

THE New York Post-Graduate Medical School and Hospital will celebrate the fiftieth anniversary of its founding at a dinner of the faculty association on January 30. The speakers will be Dr. Nicholas Murray Butler, president of Columbia University; Dr. Ray Lyman Wilbur, Secretary of the Interior, and Dr. George H. Meeker, dean of the Graduate School of Medicine, University of Pennsylvania.

ON January 18 the laboratory for the physiology of bacteria was dedicated at Cornell University by Dean Cornelius Betten. Dr. Otto Rahn gave an address on "Cell Structure and Cell Functions."

AT Northwestern University in the department of geology and geography during the first semester of the current academic year visiting lecturers and their subjects included: Dr. G. H. Cady, Illinois Geological Survey, on the "Classification of Coal"; Professor A. N. Winchell, University of Wisconsin, on "The Origin of the Graphites in Veins and Pegmatites"; Dr. G. F. Loughlin, U. S. Geological Survey, on "The Ore Deposits of Cripple Creek, Colorado"; Dr. D. G. Thompson, U. S. Geological Survey, on "The Work of the Ground-Water Section of the U. S. Geological Survey"; Professor A. C. Noé, University of Chicago, on "A Geologist in Russia"; Mr. Thomas A. Hendricks, U. S Geological Survey, on "Oklahoma Coal Measures"; Dr. T. S. Lovering, U. S. Geological Survey, on "The Geology of the Moffat Tunnel" and "The Mineral Belt of the Front Range, Colorado."

THE National Research Council has announced a new committee on accessory minerals of crystalline rocks to study the nature of such minerals, their variation in time and space in igneous bodies and metamorphosed masses and their distribution in sediments. Such studies in the past have shown that some igneous masses have rather characteristic accessory minerals which may be useful in some cases in determining the relationships between isolated outcrops, but very little is known regarding the differences in different parts of a single intrusion or in successive intrusions from a single magmatic source. The committee will attempt to correlate work now in progress and stimulate further study along these lines. At present the committee consists of E. S. Larsen, of Harvard University; J. C. Reed, of the U. S. Geological Survey; J. E. Stark, of Northwestern University; A. C. Tester, of Iowa; A. N. Winchell, of Wisconsin (chairman), and J. F. Wright, of the Canadian Geological Survey.

IN view of the disturbed economic and financial conditions in Europe and America the Council of the Institute of Metals has found it necessary to postpone the meeting, which was to have been held in the United States and in Canada next autumn. The meeting had been arranged with the cooperation of the American Institute of Mining and Metallurgical Engineers, and an assurance has been given that the members will be welcome at such later time as may suit their convenience. The Institute of Metals finished the year with a net gain in its membership of 72—compared with a net gain in 1930 of 38—thus making the total membership 2,232, the highest figures on record.

THE eighteenth annual conference of the National Association for the Prevention of Tuberculosis will be held at University College, London, on July 21, 22 and 23. The occasion will be taken to celebrate the fiftieth anniversary of the discovery of the tubercle bacillus by Robert Koch.

PROFESSOR J. W. GREGORY, as reported in *Nature*, planned to leave England on January 4 with an expedition to investigate some little-known parts of the coastal cordillera of southern Peru and their relations to the Andes and to the recent extension of South

America into the Pacific. It is hoped to examine especially the structure of the part of the Peruvian coast that trends from northwest to southeast, and the geology of the desert belt between that coast and the western front of the Andes. A geological section is also to be prepared across the little-known belt between Ica and the Urubamba valley. The earth-movements and volcanic epochs of the Andes appear to have significant correspondence in date with the main stages in the formation of the Great Rift valley that were discovered in its exploration by Professor Gregory thirty-nine years ago. The expedition will descend from the Andean plateau down one of the head streams of the Amazon, and may return to England across Brazil. Miss McKinnon Wood will accompany the expedition especially to collect fossils. Mr. A. V. Coverley Price will join the expedition at Lima. The work will be helped during parts of the journey by Mr. M. A. Tarnawiecki and Señor Don Alberto Calderon.

THE annual announcement and report of the Mount Desert Island Biological Laboratory for 1932 has been distributed recently. The booklet of thirty-seven pages contains not only the announcements for the thirty-fourth season of the Weir Mitchell Station at Salisbury Cove, and the fourth season of the Dorr Station at Bar Harbor, but also eighteen abstracts of research accomplished in 1931. Application blanks for the use of rooms, and copies of the announcement may be secured from William H. Cole, Rutgers University, New Brunswick, N. J.

THE annual report of Dr. E. D. Merrill, director of the New York Botanical Garden, records that during the year the gardens received special gifts of $18,698.47. Among these were $11,000 from the Carnegie Corporation, $1,918 from Henry W. de Forest to support exploration and investigation of the Louisiana iris and $506 from Dr. N. L. Britton for the purchase of botanical material. Added to the general endowment was a $20,000 bequest from Mortimer L. Schiff. The gardens received an unrestricted gift of $5,000 from the estate of Samuel R. Betts. Among the additions of the year was the K. K. Mackenzie herbarium of more than 60,000 specimens.

THE Department of Botany of Indiana State University has acquired the Charles C. Deam herbarium of 5,000 to 6,000 mounted Indiana plants. The collection was built up in thirty years of work throughout the state by Dr. Deam, who for many years was state forester and is now research forester of the State Conservation Department.

THE physiological institute of the University of Berne has received a gift of $3,000 from the Rockefeller Foundation for the purchase of electrical apparatus.

AN international agreement between Sweden and Denmark for the protection of migratory birds was signed recently by the Swedish Minister for Foreign Affairs and the Danish chargé d'affaires *ad interim*, and the agreement probably will be ratified by the respective governments in the near future, according to information cabled to the Department of State by Mr. John Ball Osborne, consul general at Stockholm. Among other provisions, the agreement forbids the hunting or killing of swans, the use of snares, of shotguns larger than 12 gage, and of automatic shotguns for "sea birds," and the hunting of sea birds from motor boats in the sound (between Sweden and Denmark) and other waters from May 31 to October 1.

A CORRESPONDENT of the *Journal* of the American Medical Association writes that "An accident that calls to mind the catastrophe caused, three years ago, in Belgium by the death-dealing fogs has just occurred in Lyons, although the consequences were less grave. Within a few minutes, a section of the city in which there were many factories and in which many workmen resided found that its atmosphere had become irrespirable. The people suffered from attacks of choking and coughing. The police interrupted all street traffic and ordered all the doors and windows closed. Several cases of bronchitis with choking developed in children, but no deaths occurred. An inquiry soon showed that emanations came from a factory on the banks of the river, in which various chemical products were manufactured and which produced stannic chloride, employed in the manufacture of silk goods, silk weaving being the principal industry of Lyons. This salt is obtained by the direct action of chlorine on tin, the operation being carried on in a closed vessel, because, in the open air, vapors of hydrochloric acid are produced. During the absence of the workmen, a leak developed in a lead joint, and the gas as it escaped attached itself to the droplets of water composing the fog that enveloped the city. The inquiry instituted by the prefect of the department of Rhone resulted in an order prohibiting the manufacture of this product within the city limits, which made it necessary for the factory to seek a new site outside the city. At the time of the accidents that occurred in the Meuse Valley, which cost the lives of sixty persons, the noxious gas was sulphurous anhydride, emitted by the numerous factories in this valley, which is enclosed on all sides and very winding, poorly swept by the wind and subject to frequent fogs. The Belgian inquiry resulted in the suggestion that work in the factories be interrupted on foggy days. One village (Engis), in which the general mortality has been constantly increasing during the past ten years, is threatened with the necessity of closing all its factories."

DISCUSSION

RELATIVE TO THE EXPRESSION "LINE CONTOUR"

One reads frequently in the current literature of spectroscopy of "line contours," the intended meaning of the term being, apparently, the intensity graph taken across a spectral line, or, in other words, a small part of the spectral energy curve in the immediate vicinity of the "line" or radiation in question. Inasmuch as technical usage, especially in engineering practice, has endowed the term "contour" with a special connotation of sustained equality, as, for example, in its specific application to lines of equal elevation on a topographic map, the use of the term to designate precisely *what this is not* would appear to be unfortunate.

The word has of course, in general speech, a wide meaning which is not subject to the limitations imposed by technical usage. Thus the Century Dictionary quotes Dr. Oliver Wendell Holmes in illustration: "All her contours and all her movements betrayed a fine muscular development." There is here no implication that horizontal curves only are to be considered, in fact the imagination is left free to engage itself with deflections in all directions, and it would appear permissible to speak metaphorically of the contour of a spectral line in much the same way that we refer directly to that of a body or of a feature of the landscape; but such greater latitude in the meaning of the word when employed in general speech can hardly be taken to justify its technical, and presumably exact, restriction to uses in two conflicting senses. It would seem necessary for the spectroscopist to respect the unquestionable priority of the engineer.

If we were to take over, for the description of a spectral line, the term "contour" in its engineering sense, the "contours" would be points, since the energy curve has but one horizontal dimension. The term "profile" might be appropriated with perfect consistency, since it relates to a vertical section, whose purpose is to show differences in level, and the word has in fact been drafted by Italian spectroscopists (*e.g.*, "Sul profilo del tripletto del magnesio," etc. Publ. della R. Univ. degli studi di Firenze, 48; 28, 1931). A number of other expressions are available, but the actual employment of the term "profile" in one and perhaps more of the principal languages would suggest the propriety of its use in English.

One may perhaps be permitted the reflection that a generation ago the word "contour" would probably not have been adopted by physicists or astronomers to signify something that goes up and down. The apparent readiness with which it is being accepted is perhaps illustrative of the drift of physical science from the influence of engineering, obvious to most of us, and recently remarked by Sir James Jeans ("The Mysterious Universe," p. 19). Is it too late for spectroscopists to select an expression for a simple intensity graph that would conform, or at least not be in conflict, with simple and well-established usage?

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"STRATH" AS A GEOMORPHIC TERM

In a recent number of Science, (August 14, 1931, pp. 172–173) F. Bascom proposes the word "berm" as a collective term. It is to include all terraces in stream valleys and on lake and sea shores which owe their origin to relative uplift and dissection of planation surfaces; lateral planation by streams on the one hand and planation by waves on the other.

The purpose of this note is to call attention to an anomalous circumstance. Applying the word "berm" to stream valleys is giving a name to the erosion remnant of a geomorphic feature for which in its original, uneroded condition no technical term exists. The flat bottom of a stream valley produced by degradation has no technical name to distinguish it from one produced by aggradation.

For the lowland which commonly adjoins the low-water channel (or "bed") of a stream we have the word "flood plain." But, as used, this word includes both lowlands formed by cutting away and by filling up ("degradational" and "aggradational" surfaces). The two might be distinguished as "stream-cut"[1] and "stream-filled" flood plains.[2] The latter expression is identical with "alluvial plain" and is therefore not needed. The former, on the other hand, would be inadequate. "Stream-cut flood plains" grade imperceptibly into flat valley bottoms of greater width, often spoken of as "incipient peneplains." These can not have been formed solely by lateral stream-cutting. They may owe their origin to a weathering back of the valley walls after the fashion of other erosion scarps. In fact, the writer knows of no reason why the same process that causes an erosion escarpment to retreat, with no stream running along its foot, should not also produce a recession of valley walls. Whether this inference be justified or not, the fact remains that, in general, it is not feasible to draw a line between "stream-cut" flood plains and incipient peneplains. Precise description clearly demands a technical term for degradational valley flats.

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[1] Disregarding the veneer of gravel and mud which inevitably covers a stream-cut flood plain.

[2] "Aggraded valley-plain" of C. A. Cotton, who defines "valley-plain" as "a continuous flood-plain." ("Geomorphology of New Zealand," Wellington, N. Z., 1926. Pp. 113 and 197).

The writer proposes to restrict the use of the old Scottish word "strath" to this type of flat valley bottom. According to Geikie,[3] popular usage in Scotland applies the word "strath" to "broad expanses of low ground between bounding hills, usually traversed by one main stream and its tributaries." Little violence is done to this original use when the meaning of the word is restricted in a geomorphic sense to those cases in which the flat valley bottom is the result of degradation, first by lateral stream cutting and later by whatever additional processes of degradation may be involved.

At the initial stages of lateral stream cutting, the "strath" is *incomplete,* that is, present only here and there along the valley bottom. Progressive widening renders it *complete,* a broad band of lowland between more or less parallel valley sides.[4]

The justification of this technical restriction of the word "strath" lies in the way it lends itself to the building up of a consistent nomenclature as follows.

In the course of its natural development, a *V-valley*[5] changes into a *strath-valley,* at first with an *incomplete,* then with a *complete strath.*

Rejuvenation leaves remnants of such flat valley bottoms as "terraces." Corresponding to the two types of flat valley floors we have, then, *strath terraces* and *fill terraces,* the latter comprising *alluvial terraces, glacial terraces,* etc.

To the two main types must be added a third,[6] for which the old term *rock terraces* serves well in its original meaning, which refers to ledges on valley sides brought into relief by the superior resistance to weathering of individual rock units.

Stone,[7] Stout[8] and others have used the word "strath" for what the writer proposes to call "strath-terraces." This use of the term has not been accepted widely. Since the writers who have used the term have defined the meaning in which they use it in their publications, there would be no danger of confusion if students of geomorphology should choose to adopt the writer's definition of the term here proposed.

At the mouths of river valleys strath terraces merge into wave-cut terraces. The two are by no means identical and require each a separate, specific name. Collectively they might be called "berms." Unfortunately, this word can not be used in a purely figurative sense since it is practically unknown to most readers. It would necessarily assume the character of a technical term. It is briefer to say "berms grade into partial peneplains" than to say "strath terraces and wave-cut terraces merge into partial peneplains." But it is not any more precise and therefore not necessary to do so. Every addition of a technical term which requires specialized knowledge of nomenclature interferes with the ready understanding of scientific writings by the less specialized reader. If it does not add to precision one might do better to omit a technical term, even though it be as aptly chosen as the term "berm" which, in civil engineering parlance, signifies "a horizontal ledge part way up a slope."

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OESTRUS

BY his masterly letter on the history of the word "œstrum," Dr. Tyson has justly rebuked me for my somewhat frivolous letter published on March 27.

The point is one of more than passing interest, for it involves the question of the exactness of scientific terminology. A word in general use varies from time to time both in its form and in its meaning. But a scientific term expressly adopted to convey a definite conception should, so long as it does not infringe the laws of priority and of good taste, remain inviolate. Naturally, if the conception itself becomes superseded, the term itself must pass out of use and may be adopted, preferably with some suitable alteration, with a new definition. A recent example of such a change is to be found in the alteration of the older term "lipoid" to the newer "lipid" and its variations, all of which are defined as accurately as our present knowledge of biochemistry allows.

With regard to the word "œstrum," if Dr. Tyson refers to the paper (*Quart. J. Micros. Sci.,* 1900–1,

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[3] A. Geikie, ''The Scenery of Scotland,'' 3rd Edition, London, 1901, p. 175.

[4] For the latter case Rich has suggested the term ''open valley.'' J. L. Rich, ''Certain Types of Stream Valleys and Their Meaning,'' *Jour. Geol.,* 22: 469–470, 1914. Dr. Rich agrees to this definition of his term, withdrawing the qualification given in the last paragraph of p. 470.

[5] In technical language we speak of I-beams and T-beams, not of I-shaped and T-shaped beams. It is convenient (not necessary, of course) to speak of V-valleys.

[6] The writer has used these terms for a number of years with his students in the field and classroom and has found their symmetry very useful.

[7] R. W. Stone, ''Review of General Geology of Southwestern Pennsylvania in Light of Recent Work,'' Top. and Geol. Surv. Pennsylvania, 1906–08: 121 (''These benches represent the periods when uplift ceased and the streams had opportunity to widen their valley floors, and the bluffs represent periods of elevation. These later benches are known as 'straths' ''. . .)

[8] W. Stout and R. E. Lamborn, ''Geology of Columbiana County,'' Bull. Geol. Sur. Ohio, 28: 41, 1924. (''Strath, a remnant of an old valley,'' in footnote.) W. Stout, ''Geology of Vinton County'' *ibid.,* 31: 38, 1927.

Vol. 44; see pp. 6–7) in which Heape introduced the terminology under discussion, he will find that the specific point has already been settled. Heape wished to introduce well-defined terms which would differentiate the phases of the reproductive cycle in mammals. Before giving his own choice, he discusses several alternatives, amongst them being the neuter word "œstrum." He rejects this because it already has a meaning in general use which is considerably wider than that which he desires to convey. He therefore takes the Latin word "oestrus" and gives it a clear definition, thereby introducing it as a scientific term. It seems clear, therefore, that there is very good reason for using the scientific term introduced by Heape and not the variant from general usage with a more indefinite meaning.

I feel that there is another reason why we should attempt to respect Heape's terminology, for it is said that to define a problem clearly is half the battle. Heape certainly did this for us and has thus paved the way for recent work on sex hormones which is producing such excellent results, especially in this country.

S. A. Asdell

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BOUGHS, BUTTS AND BEAVER DAMS

In Science for December 18, 1931, Mr. Charles Macnamara writes of certain beaver dams he had observed in which "at least 90 per cent." of the boughs had been placed with butt ends *downstream,* instead of upstream, as generally stated in published accounts of the beaver.

There is no question as to the accuracy of Macnamara's observations. On the contrary, as one who long has been an interested observer of the beaver and its works I am quite in agreement with him and feel that many who have written about the beaver, myself included, have, perhaps, when making generalized statements, rather unduly emphasized the position of the boughs in beaver dams. That the butt-end-upstream feature should have been singled out for special mention is probably of psychological interest only, but aside from the question of their accuracy as generalizations such statements tend to create the erroneous impression that this particular position of the boughs is a matter of design on the part of the beaver. Whatever the position of the boughs in a dam the explanation can usually be found, I think, in the conditions confronting the beaver where it is working; and some, at least, of the determining factors are fairly obvious, as, for example, the character of the stream when the dam is first started; the site of the dam and its location with reference to where the beaver gets its boughs; the route taken by the animal (sometimes forced upon it by the terrain) in transporting the boughs to the dam, and other factors.

To illustrate: The position of the boughs is, I believe, most likely to attract attention in dams that have recently been started, especially in such as contain many boughs that are fresh-cut and untrimmed and therefore particularly conspicuous. It is a matter of common observation in beaver country that many dams are started on small or shallow streams that at the time do not permit of transportation of dam materials by water; such transportation becomes possible only as construction proceeds and sufficient water becomes impounded. If, now, the beaver secures most of its boughs at points above the dam site and drags them by way of the creek bed to the dam, most of these boughs will be found on the dam with their butt ends downstream; but if most of the boughs are brought from points below the dam, then they will be found with butt ends upstream. However, many boughs may also be secured off to one side or the other of the dam and, depending in part upon the direction from which the immediate approach to the dam is made, may be found lying crosswise, diagonally or in a variety of other positions.

As the pond enlarges the beaver will very probably bring in most of the boughs from points above the dam, transporting them now by the favored water route, and hence from this time on most of the boughs will doubtless be found, when in place, with butt ends directed downstream.

If any general statement is to be made in regard to the position of the boughs in beaver dams, rather than making any reference to the direction in which the butts are pointing it might be safer merely to say that most of the boughs lie parallel with the stream or the direction of the flow.

Charles E. Johnson

Roosevelt Wild Life Station
N. Y. State College of Forestry, Syracuse

TWISTED TREES

A brief note, under the above caption, by Dr. A. R. Cahn, of the University of Illinois, appeared in Science several months ago (May 23). In it Dr. Cahn recorded his observations in Ontario, Canada, of evergreen trees having twisted bark and wood. Noting that the twist, in the trees observed, was predominantly to the right, he wondered why this was so. In a letter to Dr. Cahn on June 1 the following explanation was offered.

When a tree is exposed to the wind year after year, it assumes an oval shape, when considered in horizontal cross-section through the leafy portion of the tree. The trunk would be off-center on the side toward the direction of the wind. If the prevailing wind shifts from left to right consistently in the area in which the tree is located, it would seem that there would be a natural tendency to twist the tree from the left to the right. In other words, it would appear, if this explanation is correct, that the tree is a recording weather vane.

On return to his office this fall, Dr. Cahn replied to my letter and stated that he had come to about the same conclusion and suggested that this note be put in SCIENCE.

NEALE F. HOWARD

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"RICKETTSIA" AND "SYMBIONTS"

GLASER'S comment on our paper[1] (SCIENCE, September 4, 1931, p. 243) does not help to clarify the problem. We are in entire agreement that "Tinctorial properties *alone* (italics ours) do not constitute valid taxonomic characters." We attempted to point out that there are in the insects studied by us organisms which differ morphologically, tinctorially and culturally from other known bacteria as well as from the so-called "Symbionts." Symbionts in various insects probably consist of a variety of bacteria, while the organisms grown by us were uniform in character and appeared in every way to correspond to the description of classic Rickettsia. Therefore, we urged that for sake of clarity we cease confusing "Rickettsia" with "Symbionts." Even conservative bacteriologists, and we count ourselves in that class, have recognized the wisdom and conservatism of dividing the erstwhile genus *Bacillus* into a number of distinct genera. Differentiation of unrelated groups can hardly be considered "splitting," even by the ultra-conservative.

I. J. KLIGLER
M. ASHNER

JERUSALEM,
OCTOBER 20, 1931.

REPORTS

FORMAL OPENING OF THE NEW BERMUDA BIOLOGICAL STATION FOR RESEARCH

THE formal opening of the Bermuda Biological Station for Research, Inc., and the induction into office of its new director, Dr. J. F. G. Wheeler, took place at the new home of the station, "Shore Hills," St. George's West, Bermuda, on Wednesday afternoon, January 6, in the presence of His Excellency, the Governor of Bermuda, General Sir Thomas Astley-Cubitt, K.C.B., etc., and members of his family, members of the Colonial Government and more than five hundred invited guests. Six trustees of the station went down from New York with five guests, two of the Bermuda trustees were present and took a leading part in all the arrangements.

The band of the Northumberland Fusiliers was present in brilliant uniforms, and their music added materially to the pleasure of those attending the function. Special trains on the newly opened railroad conveyed guests from Hamilton and St. George, and Bermuda papers reported the gathering as "the most distinguished and representative seen on any public occasion for many years."

The governor and his party were met by the trustees at the south entrance and were seated in the open court, while the other guests came in by the north entrance and were seated in the verandas and balconies surrounding the court, where the exercises took place. Mr. F. G. Gosling, trustee of the station and for thirty years active in the development of scientific work in Bermuda, opened the exercises with a brief account of the steps which had led up to the present consummation. Thirty years ago, he said, the Bermuda Natural History Society was formed with the prime object of establishing the Bermuda Biological Station and the Public Aquarium. On every occasion the legislature had granted money when approached by the society and this culminated last year when £5,500 was given to assist in acquiring the present site. The Rockefeller Foundation had most generously supported the scheme and had made possible the present splendid development. The result was that to-day Bermula could take great pride in the part played by the government and people in the establishment of the station, which was a purely scientific institution, without any commercial object or aim. He especially commended the action of the trustees in appointing a British subject as the first director of the reorganized station, which statement was loudly applauded. He then introduced Dr. E. L. Mark, of Harvard University, the former director of the old biological station, saying that Bermuda owed him a deep debt of gratitude for his efforts and insistence in helping to bring the station to its present stage.

Dr. Mark, who was warmly greeted on rising to speak, was obviously overjoyed that his dream of so many years had come true, and we give his summary of the history of the station.

Your Excellency, Ladies and Gentlemen: My first impulse is to call you—as many of you long have been—my dear friends.

It is a great pleasure to meet you collectively and to express my keen appreciation of what you have done, both officially and unofficially, to further the interests of the Bermuda Biological Station for Research.

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[1] *J. Bacteriology*, 22: 103–114, 1931.

The establishment of the station in 1903 was made possible by the cooperation of several interests. My own participation is due to suggestions made by Charles Eliot, president of Harvard University (who spent the winter of 1900–01 in Bermuda) and to my meeting by chance the late Professor Charles L. Bristol, of New York University, whose pioneer work in advocating the aquarium and station is well known to all Bermudians.

At the invitation of the Bermuda Natural History Society, Professor Bristol and I visited the islands in April, 1903, with a view to aiding in the selection of a site for the station and a public aquarium, the latter to be owned and controlled by the Colonial Government.

After a careful survey of various regions—having in mind the facilities for research, as well as the all-important matter of income from entrance fees to the aquarium—the Flatts Inlet was selected.

By an agreement between New York and Harvard Universities, it was arranged that the station should be established with the aid of funds raised for the purpose by the representatives of the two universities, *viz.:* by myself as director, and by Dr. Bristol as associate director. The laboratory equipment was purchased with funds solicited from graduates of Harvard University, and the station was opened in June, 1903, at the Hotel Frascati. All properly qualified persons (women as well as men), from whatever institution they came, were admitted without fees on equal terms.

For two more summer seasons (1904 and 1905) the work was carried on at the Frascati, and meantime plans for a more permanent location were perfected. Through the agency of the Natural History Society, it was proposed that the Colony should buy a suitable piece of land from the Allen estate near the bridge and should erect on it a building, the lower story of which should be devoted to the aquarium and the upper story placed at the disposal of the biological station. The land was bought, but, unfortunately for the rest of the plan, the War Department of Great Britain about this time suffered a 50 per cent. reduction, which had the effect of greatly diminishing the income of the Colony, so that it was impossible to complete the whole plan. As a result, no work was carried on during the summer of 1906. However, by a fortunate turn of events, Agar's Island became available for this purpose. The society was able to rent the island from the War Department and proceeded (as you know) to convert its "Magazine" into an aquarium. At the same time—the agreement between New York and Harvard Universities having been dissolved—I was invited to resume, as director, the work begun at the Flatts. Accordingly, the laboratory equipment of the station was transferred from the Flatts to a large building on Agar's Island, and those in attendance on the summer session of 1907 were lodged in the cottages on the property.

From the time of the resumption of work in 1907, it had been the aim to provide for investigators at all seasons of the year, but it was not until 1915 that such a plan was fully realized by the appointment of Dr. William J. Crozier as "resident naturalist."

Until April, 1917 (when the United States entered the "World War"), we had remained in undisturbed possession of the island, but unexpectedly we were then notified that we must at once vacate the place, and the whole equipment was transferred to Denslow's Island, where by the generous terms of the owners we were able to reestablish the laboratory.

Some months after the signing of the armistice, *viz.*, in May, 1919, we were allowed to resume possession of Agar's Island. From that time on (the aquarium having been closed), the money so generously granted by the legislature was turned over to the director of the station, who as the representative of Harvard University rented the island from the War Department, and continued so to do till it was sold to Furness, Withy and Company. Since then, through the liberality of the owners, we were permitted to occupy the island till the middle of last June, when the equipment was turned over to the Bermuda Biological Station for Research, Inc. (in accordance with an understanding with Harvard University) and transferred to Shore Hills.

Such is, in brief, the outline of the history of the unincorporated station. As to the scientific results of activities at the station, I must refer you to the nearly 170 articles published by workers at the station. Reprints of these papers are collected into six completed volumes, and one nearly completed, of the Contributions from the station, a set of which you will find in the library on the second floor of this building.

I greatly regret that the time available does not permit me to enumerate the persons who have been most active in supporting financially, and otherwise, the activities of the station, and also the long list of distinguished biologists whose work is evidence of the value of the opportunities provided for them.

In closing, I can do no better than bespeak for my successor, Dr. Wheeler, and the enlarged oceanographic aims of the station a continuance of that loyal and hearty support you of Bermuda have given in the past.

At the conclusion of Dr. Mark's address, Mr. F. G. Gosling requested His Excellency to declare the station open, which he did in the following words:

I do not have to open a dictionary to find out what "biology" means, but I can see at a glance that Bermuda is fortunate to have such an institution as this, and I can think of no more beautiful and convenient site. I have not had the pleasure of visiting the station before, but in common with many others, it will give me great delight to visit it on many occasions in the future. I am not quite sure whether Dr. Beebe will be transferred to this station or whether he is a different biological specimen, but it is most gratifying to know that Bermuda attracts such eminent scientists as now visit and work in this island. I feel sure, too, that to Mr. F. G. Gosling we owe many thanks for his long and enthusiastic work on behalf of this station.

St. George's is a most appropriate site for the institution, [he continued amid laughter] for it was here that the first biological specimens arrived on the island.

It gives me much pleasure to declare the station open, and I wish it every success.

Dr. E. G. Conklin, of Princeton University, president of the Bermuda Biological Station, then spoke of the organization and aims of the Station as follows:

Your Excellency and Honored Guests:

The question has been raised by several of our guests as to how the new Bermuda Biological Station for Research differs from the old one and from Dr. Beebe's Bermuda Oceanographic Expedition. These differences may be characterized in three paragraphs.

(1) In the first place this new station differs from any and all others in this hemisphere or in the entire world, so far as I know, in being really international in its organization. At the initial meeting of the promoters of this new station it was decided to ask leading scientists and contributors to the cause of science in all countries to join in forming a corporation which would be the ultimate body owning and controlling this station. There are now more than two hundred members of this corporation, representing ten different countries. This large corporation then elected a board of trustees to administer the affairs of the station, and in 1926 this organization was incorporated under the laws of the state of New York. There are now twenty-three trustees in our board, representing Bermuda, Canada, England, Scotland and the United States; our organization is truly international and in this respect differs from all other biological stations in this hemisphere.

(2) In the second place the Bermuda Biological Station, like the Marine Biological Laboratory at Woods Hole, is a cooperative institution in the widest sense. While it is the purpose of the trustees to have, as soon as possible, a resident scientific staff, in addition to our resident director, carrying on a program of research in the physics, chemistry and biology of the ocean in the vicinity of Bermuda, this station will also afford opportunities to competent scientists from all countries to pursue independent researches on these subjects, or to join in the general work of the scientific staff. For many years to come, perhaps indefinitely, the major work of the station will consist of such independent investigations of visiting scientists. Already inquiries or applications for research space have come from leading scientists of Canada, England, Scotland and the United States, and there is abundant evidence that the Bermuda Station may count upon the scientific cooperation of scientists throughout the world.

Cooperation is also manifest in the financial as well as in the scientific support of the station. The Bermuda Government by its grant of £5,500 on condition that £50,000 be secured elsewhere took the initial step in this cooperation. The Rockefeller Foundation by its grant of £50,000 met this condition. In addition the Bermuda Government has for several years given £200 a year toward the support of the station and has granted duty-free importation for all equipment and supplies. The Royal Society of London at the initiation of this new organization made a small grant, to indicate its interest in and cooperation with the Bermuda station. Last July the Empire Marketing Board of Great Britain made a conditional grant to the station of £2,500, but owing to the financial crisis has been compelled to postpone this indefinitely. To meet the requirements of our budget in these times of financial stress the Rockefeller Foundation has recently made an emergency grant of $6,000 a year for a period of two years. In return for the use of the facilities of this station the Woods Hole Oceanographic Institution has contributed $2,000 for the current year, and seven universities and scientific institutions in the United States and Canada have agreed to support research tables or rooms at the station. Undoubtedly this number of cooperating institutions can be greatly increased in the near future. In addition to this governmental and institutional support the station has received aid from many individuals, in the form of money, instruments, books and journals, and last, but not least, generous contributions of labor, time and advice. To all these cooperating organizations and individuals we extend hearty thanks and bespeak the continuance and extension of their interest and support.

In order to correct any misunderstanding that may exist as to the purchase of the Shore Hills property and its remodeling for the uses of the station, I may say that the trustees paid to the former owners $80,000 from the Rockefeller grant and that the entire sum given by the Bermuda Government has been spent here in Bermuda for the necessary alterations and repairs.

(3) A third characteristic of the new Bermuda Biological Station is the breadth of the scientific work which is contemplated. This will make it much more than a biological station, for in addition to the usual work of a marine biological laboratory and the extraordinary opportunities offered here for the study of the physiology and life-histories of deep sea animals, we propose to investigate the physics and chemistry of the waters as well as their biology. There is offered here an almost unrivalled opportunity to make an intensive and long-continued study of the drift, temperatures, salinity, oxygen content, etc., of ocean waters down to a depth of more than 2,000 fathoms, and the relation of all these environmental factors to the kinds and abundance of living forms. We expect to study the causes and rate of reef-formation, erosion and sedimentation, but we do not imagine that we can ever raise the level of these islands some thirty feet and thus increase their area approximately twenty times, to their original dimensions, as was humorously proposed to us by the late governor, General Bols. We do hope to make extensive surveys of the ocean bottom with accurate determinations of the force of gravity, bottom deposits, etc., and thereby add to our knowledge of the causes at work in the formation of oceanic islands, but we do not anticipate that such studies will have any immediately practical value. They may never increase the food supply nor the means of living, but they should furnish much food for thought and should increase and ennoble the aims and joys of living.

One hundred years ago a wise and generous English-man, James Smithson, bequeathed to the United States of America a fortune of more than half a million dollars "to found at Washington under the name of the Smithsonian Institution an establishment for the increase and diffusion of knowledge among men." Thus was created one of the first and greatest scientific institutions of the New World. We who are concerned with the foundation and development of the Bermuda Station wish to emulate the example of James Smithson and to establish here in this British Colony, this island paradise, an institution "for the increase and diffusion of knowledge among men," and to this end we invite the cooperation of governments, foundations, universities and individuals. What other objective is more worthy of high endeavor and great endowment?

This institution is not finished, but only begun. Its long period of incubation under the supervision of Dr. Mark has finally led to its birth in this beautiful and strategic site. Before it, let us hope, lies immortal youth and growth, and ever widening usefulness in the highest service to mankind!"

President Conklin then inducted the new director into office in the following words:

> John Francis George Wheeler, B.Sc. and D.Sc. of the University of Bristol and formerly lecturer in the same, student at the Plymouth Laboratory of the Marine Biological Association of the United Kingdom, investigator for the Ministry of Agriculture and Fisheries, zoologist with the *Discovery II* Expedition to South Georgia and South Africa in 1924–27, and again in 1929–30, for the last year in charge of the *Discovery II* office in London, author and co-author of notable monographs on Southern Blue and Fin Whales—By the authority and in the name of the trustees of the Bermuda Biological Station for Research I induct you into the office of director. I charge you to remember that this is a cooperative and not a one-man institution. I bespeak for you and for Mrs. Wheeler the cordial friendship of the people of Bermuda, and I pledge you the support of the corporation and trustees in the further development of this station.

Dr. Wheeler responded in a brief address, in which he said that he was deeply conscious of the great honor and responsibility that had been conferred upon him. He felt that he and his wife had joined a family community in Bermuda and he realized that he was following in the steps of a long line of scientists who had labored to establish the Bermuda Station. There was, he said, a wonderful opportunity for scientific work here, for the ocean abounded with life and it was the duty of scientists to study that life and to make their studies of service to mankind. He spoke particularly of the many correlations of plants and animals in the sea and illustrated this by his studies on the whales of the Antarctic, and then pointed out the bearing of all these correlations on the whaling industry and the manufacture of soap. He ended by expressing his confidence in the support of the board of trustees and of the government and people of Bermuda.

At the conclusion of this ceremony guests were invited to inspect the various aquaria, laboratories, library and living rooms at the station and to partake of tea and refreshments in the main hall and dining room. Thanks to the spacious quarters and to the interesting exhibits it was possible to entertain the entire company in a satisfactory manner.

The concluding paragraph of the extended account given in the *Royal Gazette and Colonist Daily* may be quoted as an indication of the general impression in Bermuda of the new biological station:

> And so concluded an event that marks an era in the history of Bermuda. Everyone present was deeply impressed with the importance of the occasion and there is little doubt that the Bermuda Biological Station is destined for a great future. To all those who have contributed to its foundation Bermuda owes a debt of gratitude difficult to express or repay.

E. G. CONKLIN

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONVENIENT PREPARATION FOR THE REMOVAL OF HAIR

THE depilatory, reported in this paper, has been used in my laboratory for some time. At the suggestion of some colleagues, I have decided to describe the method used for preparing it.

This preparation is *very toxic* if injected subcutaneously or intraperitoneally into white rats or guinea-pigs. There, however, are no apparent toxic effects when it is used for removing hair from large areas on laboratory animals.

There are several advantages in using such a hair remover: (1) inexpensiveness, (2) ease of preparation, (3) quick action, (4) a smooth unscarred area which is necessary in certain types of investigation, and (5) the activity does not decrease markedly on standing.

EXPERIMENTAL

The apparatus consists of three one-liter flasks, one one-hole rubber stopper, one two-hole rubber stopper, glass tubing and rubber tubing for connections. The arrangement of the apparatus is shown in Fig. 1.

Hydrogen sulphide is generated by means of ferrous sulphide and hydrochloric acid in flask No. 1. The gas passes through flask No. 2, which is about

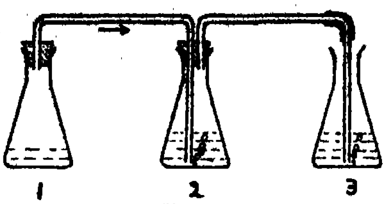

FIG. 1.

one half full of distilled water. Flask No. 3 contains an aqueous solution of barium hydroxide.

The following preparation keeps its activity very well and removes hair in 3 to 5 minutes from areas large enough for ordinary operative purposes. Forty grams of powdered barium hydroxide were added to flask No. 3, which contained 500 cc of distilled water. The contents of the flask were agitated occasionally during several hours in order to insure solution (an electric stirrer would cut down the time and eliminate the shaking). The hydrogen sulphide was generated by treating one ounce of granulated ferrous sulphide with 200 cc of 1–2 hydrochloric acid. The gas was washed by means of the water in flask No. 2 and passed directly into the aqueous solution of the barium hydroxide, which was agitated continuously for the first few minutes and then at intervals of a few minutes. The hydrogen sulphide was allowed to pass into the solution for thirty minutes or until the supply was practically exhausted. The apparatus was disconnected and twenty-five grams of powdered barium hydroxide were gradually added while stirring the solution. After testing the solution for its activity by means of laboratory animals (a small area on one's arm may be used), it was stored in a brown bottle.

The application of the depilatory must be attended with some precaution since the solution will dissolve the nails and cuticle as well as the hair. If one will take 25 to 50 cc of the solution in a beaker and apply it gently by means of a small piece of gauze and a pair of forceps, he will obtain good results. If the coat of hair is heavy, it will be necessary to keep adding fresh solution from the beaker for several minutes. A tongue depressor, spatula or some blunt-edged instrument may be used to gently remove the most of the dissolved hair. The animal is held under a stream of warm water in order to wash off the depilated area and free it from the barium solution. It is best to keep the animal in a warm place until dry and longer if the depilated area be very large.

DISCUSSION

Since the solution was found to be toxic if administered subcutaneously or intraperitoneally, one might expect that it would be injurious if it were used for removing hair. It, however, has been used on dogs, rabbits, guinea-pigs and white rabbits without any apparent deleterious effects.

The depilated areas seemed to grow hair at a slower rate than similar areas which were shaved.

The solution, made according to the method as described above, will retain its activity for several months. The quantity of barium hydroxide treated with hydrogen sulphide and the quantity of barium hydroxide added to the treated solution can be varied somewhat without markedly affecting the activity of the depilatory. One solution, containing approximately the same amount of barium hydroxide as used in the above method, was quite active after standing for one year.

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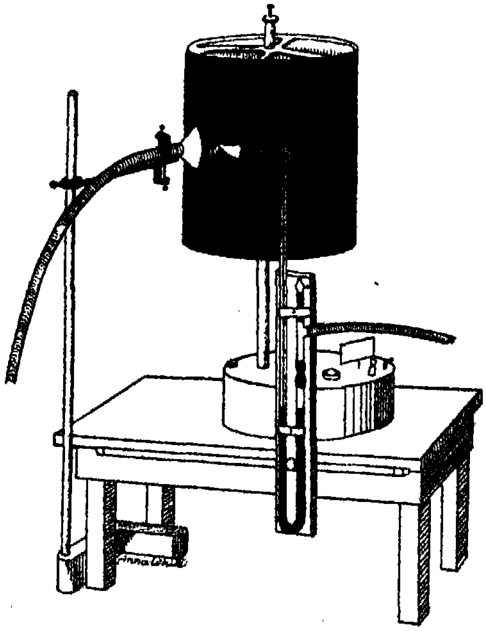
AIR CONTROL OF MANOMETER WRITING POINTS[1]

ARTERIAL and venous pressures are often recorded on a smoked drum by means of a writing point attached to a float. Various devices are used to keep the writing point in contact with the drum in such a manner that a clear tracing will be obtained without so much friction that the recording of pressure changes will be interfered with. This is a simple matter with mercury manometers but when water manometers are used it is often very difficult to obtain a good tracing. A simple method of keeping the writing point against the drum with a delicate but even pressure is shown in the accompanying illustration. A stream of air is blown against the writing point, pressing it against the drum. By regulating the air current the contact of the writing



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[1] Demonstrated at the meetings of the Federated Biological Societies at Montreal, 1931.

point with the drum can be very delicately adjusted. The matter of obtaining a uniform pressure over a large range of movement of the pointer is a difficult one on account of air eddies, but a very satisfactory air stream for recording small changes of pressure can be obtained by blowing air through an ordinary fish tail burner tip, commonly used on Bunsen burners, as illustrated in the figure.

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SPECIAL ARTICLES

PRE-CARBONIFEROUS FORAMINIFERA

THE foraminifera, representatives of the most primitive invertebrate phylum, are, paradoxically enough, essentially missing from the roster of the geologically older faunas. The various reasons for their apparent absence can not be discussed here; but because our paleontologic knowledge of the group prior to the mid-Mississippian (when at least one species, *Endothyra baileyi,* definitely became abundant), is so scanty, even the vaguest pre-Carboniferous foraminiferal record is eagerly sought for by paleontologists.

The specimens recorded from the pre-Cambrian of Brittany by Cayeux, however, are regarded by many as unauthentic. Those described by G. F. Mathew from the Cambrian of New Brunswick, according to Howell,[1] turn out to be phosphatic concretions; and a large percentage of the few Cambro-Ordovician and Silurian species of Europe, described by Chapman, Ehrenberg, Brady, Terquem and Keeping, has been looked upon with considerable skepticism by some paleontologists. In 1930, however, Moreman[2] described a rich faunule of arenaceous foraminifera from the Silurian Chimney Hill formation of Oklahoma, and a few species from the Arbuckle and Viola formations. This was the first *bona fide* North American occurrence of pre-Carboniferous age to be reported. But since the appearance of Moreman's paper, Whitcomb[3] has reported (but not described) Ordovician foraminifera from Pennsylvania, and Thomas[4] has described posthumously a single Devonian species from Iowa. To these three American records it is now possible to add a number of others.

For several years a group of graduate students, under the direction of the senior author, has been carrying on detailed micropaleontologic examinations of the older Paleozoic sediments of Ste. Genevieve County, Missouri. As some of these investigations have resulted in the discovery of arenaceous foraminifera in considerable abundance, it is thought advisable to make announcement of this important fact prior to the publishing of the detailed descriptions of the faunas.

Late in 1930 Mr. Dunn found a number of arenaceous foraminifera in siliceous residues of the Bainbridge limestone (Niagaran of southeastern Missouri). Accordingly, on our return to the University of Chicago's Missouri Field camp in June, 1931, we were equipped to carry on microscopical studies of the sediments essentially at their outcrops. In this way it was found that almost all samples of the Bainbridge, regardless of lithologic appearance and stratigraphic or geographic position, contain foraminiferal remains. The Brassfield (Alexandrian) strata of southeastern Missouri also were found to carry an abundant fauna; and later it was discovered that a suit of Brassfield samples, collected by Professor D. J. Fisher near Joliet, Illinois, was likewise replete with the same general types of foraminifera. Furthermore, although the suspected remains thus far found are decidedly fragmental, we have a strong suspicion that the Niagaran beds of the Chicago area and the Waldron strata of Indiana also contain similar forms, though in considerably diminished numbers. So far as the Waldron is concerned we understand that this suspicion is shared by Professor Willard Berry, of Ohio State University. Mr. Dunn will soon have the results of the research on these Silurian sediments ready for publication. In the meantime, however, it may be pointed out that forms similar to if not identical with the following typical Chimney Hill species are common in the Bainbridge fauna:

Ammodiscus excertus, Cushman.
Ammodiscus incertus (d'Orbigny).
Bathysiphon curvus, Moreman.
Colonammina conea, Moreman.
Lagenammina stilla, Moreman.
Lituotuba exserta, Moreman.
Psammosphaera cava, Moreman.
Sorosphaera tricella, Moreman.
Thurammina triangularis, Moreman.

The similarity of these unusual faunas suggests the possibility of accurate correlation of a number of mid-Paleozoic formations on the basis of arenaceous foraminifera. The writers are fully aware of the fact that this is in part a presumption. The effectiveness of such a correlation scheme depends not alone upon the extent to which the foraminifera can be found in beds wherein their presence previously has not even been suspected, but also upon whether such primitive types change sufficiently during a relatively short elapse of geologic time to be really diagnostic. The tremendous geologic range of such species as the modern *Ammodiscus incertus* (d'Orbigny) might seem to indicate that they do not, but on the other hand there is no difficulty in separating Alexandrian Brassfield samples from the Niagaran Bainbridge sediments solely on the basis of differences in their foraminiferal remains. That a number of other mid-Paleozoic formations may yield foraminifera when the unsoluble residues are studied is suggested by the fact that we have also found the Helderbergian Bailey formation of southeastern Missouri to contain their abundant remains, though the assemblage has not yet proven to be particularly diversified. This new fauna is being described by Mr. Hunter.

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[1] B. F. Howell, Appendix E, Rept. Nat. Research Council Sub-committee on Micropaleontology, April, 1931.
[2] W. L. Moreman, *Jour. Paleont.*, iv, 1, 1930.
[3] L. Whitcomb, Appendix E, Exhibit A, Rept. Nat. Research Council Sub-committee on Micropaleontology, April, 1931.
[4] A. O. Thomas, *Jour. Paleont.*, v, 1, 1931.

In addition to the very definite discoveries mentioned above, it may be well to list the less positive and the entirely negative results of our studies. The Oriskanian Little Saline limestone pretty certainly contains these microscopic organisms, although our specimens are thus far both rare and discouragingly fragmentary. The mid-Devonian Grand Tower, Beauvais and St. Laurent formations have been carefully examined, thus far with only negative results. The Ordovician Joachim formation apparently does not contain foraminifera, but there is evidence, still far from certain, that the Plattin, Kimmswick and Fernvale may yet yield unquestionable specimens. A number of older formations of the Ozarks, such as the Gasconade, Jefferson City, Cotter and Powell, also have been studied, but without positive results. As H. S. McQueen, of the Missouri Bureau of Geology and Mines, however, has run literally thousands of careful mineralogical studies on the insoluble residues of these sediments without noticing foraminifera, we may at least assume that very few of the organisms were preserved in these strata.

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TREATMENT OF COTTON ROOT-ROT WITH AMMONIA

A TOXIC effect of ammonia on the root-rot fungus, *Phymatotrichum omnivorum* (Shear) Duggar, has been determined as a result of a series of experiments in growing the fungus in different media, during the season of 1931. When ammonium salts were used as the source of nitrogen in Duggar's solution, the growth of the fungus was notably restricted, and this indication was confirmed by subsequent tests. It was found that both the mycelial and sclerotial stages of the fungus were killed by short exposure to the gas, and where dilute concentrations of the hydroxide were applied under field conditions, the fungus was killed in the tissues of cotton roots.

In the cultural experiments with ammonium nitrate and ammonium sulfate, when used at a concentration to yield approximately 12.4 grams of nitrogen per liter, very little growth of mycelium appeared after intervals of 11, 18 and 31 days, whereas the other sources of nitrogen, *viz.*, calcium nitrate, potassium nitrate and sodium nitrate, produced an abundant growth.

After pH readings had revealed that the suppression of growth with the ammonium salts was not attributable to an acid reaction of the media, the apparent toxic effect was studied. The procedure was as follows: fresh cultures were prepared in 125 cc Erlenmeyer flasks containing 50 cc of neutral carrot agar, and after growth was well established over the media, the mycelium in each of four flasks was exposed for 20 minutes to dilute ammonium hydroxide (.1, .5 and one per cent. by volume, prepared from 28 per cent. ammonia water). Four untreated flask cultures were reserved as checks. After the above exposures, transfers were made immediately from the treated and check flasks to neutral carrot-agar slants in test-tubes. In every case, the inoculum from the cultures treated with ammonium hydroxide failed to grow, but growth occurred in all cases from the check inoculum.

Other flask cultures were subjected to ammonia treatment for 30 seconds by generating the gas from 500 cc of 28 per cent. ammonia water and allowing this to enter the culture flask by means of glass tubing. The gas treatment also completely inhibited growth of the fungus when transfers were made. Further tests were made with root-rot sclerotia by exposing them to ammonia, chlorine and formaldehyde gas for short intervals (10, 15 and 20 seconds) with the ammonia treatments showing complete mortality.

Roots obtained from freshly wilted cotton plants were exposed to the same gases for intervals of 30 seconds and of 1 and 2 minutes and later tested for viability of the fungus in moist chambers. The ammonia treatments prevented growth, while the formaldehyde and chlorine were only partially effective. Good growth occurred in all of the checks.

Field tests have also been conducted at various times during the season to compare the effectiveness of 6 per cent. solutions of ammonium hydroxide, formalin and sodium hypochlorite when applied in the soil to the roots of infected cotton plants. In these experiments large mature plants were selected and treated with the different disinfectants by saturating the soil about the roots of the plant. After forty hours the plants were removed from the soil and the roots placed in moist chambers. Observations were made at one-day and five-day intervals. Plants treated with ammonium hydroxide showed no growth of mycelium; the plants treated with formalin, slight growth; those treated with sodium hypochlorite, good growth; the checks, good growth.

The disinfection with ammonia appears to be more complete than with other chemicals used in comparative tests, and the danger of killing adjacent plants, as by formalin treatments, is avoided. The possibility of utilizing ammonia or ammonium compounds for the control of the disease in cotton fields as well as for protecting ornamentals or shade trees is suggested, and further experiments are being made.

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PREVENTION OF BLOOD COAGULATION BY CYSTEINE[1]

IN 1928[2] one of the writers reported that when oxidation in Berkefeld filtrates of the Rous chicken tumor was prevented by means of cysteine, the spontaneous loss of infectivity of the filtrates which takes place rather quickly with this virus is very markedly inhibited. At the same time a precipitate which usually forms under aerobic conditions, varying in degree from a slight opalescence to a definite flocculation, no longer occurs, and the filtrates remain water clear for days, as long as they are protected from the air. It was at first believed that this precipitate was in some way connected with the filterable virus, since "infectivity" disappeared more or less parallel with its formation. Control experiments, however, in which Berkefeld filtrates of embryonic chick tissues were prepared, showed this precipitate to an even more marked degree than tumor filtrates, and here, too, its formation was largely or completely prevented by reducing with cysteine.

The precipitate appeared to consist of protein, and the possibility was obvious that it resulted from a slow coagulation of some of the saline soluble tissue proteins and that oxidation played a part in its formation. It was logical to inquire whether oxidation might enter into the chain of events resulting in the coagulation of blood. There has been in the past some evidence to this effect, but as far as we could find from a hasty review of the recent literature, nothing very direct.

It was a simple matter to withdraw a few cc of human blood in an oiled syringe and transfer 1 cc quantities to three test-tubes, each containing two glass beads. One tube served as control, containing 0.5 cc of saline. The second tube contained 0.1 g of cysteine hydrochloride, neutralized with NaOH in 0.5 cc saline, and the third tube 0.1 g of alanine in saline as a control on the NH_2 and COOH portion of the cysteine. The blood in each tube was quickly covered with 2 cm of melted vaseline. By tilting the tubes at intervals, it was possible to observe when coagulation took place by the movement of the glass beads. Tubes 1 and 3 coagulated in about ten minutes. Tube 2 remained completely uncoagulated for twenty-four hours, was then opened, the blood drawn off, and found to be quite fluid, and was discarded. Repetition of the experiment showed that 0.01 g of cysteine hydrochloride was insufficient to prevent the coagulation of 2.0 cc of blood, but that 0.05 g would do so.

Further experiments indicated that thorough aeration of the cysteinized blood, leading to oxidation of the cysteine to cystine, would result after some time in coagulation.

The further analysis of the mechanism of this phenomenon is definitely outside the scope of a bacteriological department, but the experiment can be so easily repeated that it seems worth while to describe it in the hope that by means of it some further light may be shed on the obscure question of blood coagulation.

J. HOWARD MUELLER
SOMMERS STURGIS

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[1] From the Department of Bacteriology and Immunology, Harvard University Medical School, Boston.

[2] J. H. Mueller, SCIENCE, 68: 1752, 38, July 27, 1928.

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SPECIAL ISSUE CONTAINING REPORTS OF THE SECOND NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES

SCIENCE

VOL. 75 FRIDAY, FEBRUARY 5, 1932 No. 1936

The New Orleans Meeting of the American Association for the Advancement of Science and Associated Societies: DR. CHARLES F. ROOS.
General Features 141
Registration 142
General Reception and Entertainment 142
The Press Service 143
The Science Exhibition 144
The Association Prize 144
Business Proceedings of the Council 146
The President-elect 147
The Secretaries' Conference 148
The General Sessions 149
The Scientific Sessions at New Orleans:
Section A (Mathematics) and Related Organizations 150
Section B (Physics) and Related Organizations 152
Section C (Chemistry) 154
Section D (Astronomy) 155
Section E (Geology and Geography) and Related Organizations 155
Section F (Zoological Sciences) and Related Organizations 156
Section G (Botanical Sciences) and Related Organizations 158
Organizations Related to both Sections F and G 161
Section H (Anthropology) 162
Section I (Psychology) and Related Organizations 163
Section K (Social and Economic Sciences) 164
Section L (Historical and Philological Sciences) 165
Section M (Engineering) 166
Section N (Medical Sciences) 167
Section O (Agriculture) and Related Organizations 168
Section Q (Education) 170
Organizations Related to All Sections 171

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THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES

Edited by Dr. CHARLES F. ROOS
PERMANENT SECRETARY

GENERAL FEATURES

THE eighty-ninth meeting of the American Association and associated societies at New Orleans, Louisiana, from December 28, 1931, to January 2, 1932, will undoubtedly go down in history as one of the major meetings of the association. Over 1,300 papers, many of which were of fundamental importance, were read. Scientists came from 46 states and several foreign countries. A number of societies and sections united in important symposia which should result in great scientific advances. A preliminary announcement of the meeting appeared in SCIENCE for November 27, 1931.

The local committee, headed by Dr. D. S. Elliott, of Tulane University, gave much attention to the meeting and as a result the details were competently worked out. The sessions of the association and associated societies were very satisfactorily accommodated in the buildings of Tulane University, the Municipal Auditorium and the convention rooms of the various hotels which served as headquarters for the association and the associated societies.

The president for this meeting was Professor Franz Boas, of Columbia University. Professor Boas is known throughout the world for his important contributions to anthropology and is frequently called the dean of American anthropologists. Professor Boas gave much time and care to arranging an important symposium on "Growth" (see Section H reports) and expected to lead it, but a serious illness prevented him from attending the meeting. In the absence of Professor Boas, the senior vice-president, Dr. E. D. Merrill, of the New York Botanical Garden, became the presiding

The retiring president for the New Orleans meeting was Professor Thomas Hunt Morgan, of the California Institute of Technology, eminent leader in zoological research and teaching, and a pioneer in genetics research. Professor Morgan was seriously injured in an automobile accident in the early part of October and, although convalescing nicely, was not able to prepare his retiring address and attend the meeting.

REGISTRATION

All fifteen sections of the association were officially represented on the program. Thirty-four associated and invited organizations of scientific workers joined with the association on this occasion. Altogether there were 1,372 papers read, including 109 which were read by title.

Fourteen hundred and forty-seven persons were actually registered at the association's registration offices. Many present did not register, and it is therefore impossible to tell how many attended the scientific sessions. Indications are that between 2,500 and 3,000 persons attended one or more of the technical sessions of the association or the associated societies. Each of the general evening lectures at the Municipal Auditorium was attended by over 1,500 persons. The average attendance at these sessions was about 1,700. An actual count showed that in excess of 15,000 persons entered the Science Exhibition through the main entrance. No check of those passing through two auxiliary entrances was made.

REGISTRATION AT THE OFFICES OF THE A. A. A. S. BY STATES AND PROVINCES

New Orleans	103	Missouri	60
Canada	12	Montana	4
Foreign	8	Nebraska	11
Alabama	29	New Hampshire	7
Arizona	12	New Jersey	18
Arkansas	15	New Mexico	7
California	33	New York	101
Colorado	11	North Carolina	16
Connecticut	13	North Dakota	8
Delaware	3	Ohio	40
District of Columbia	72	Oklahoma	40
Florida	53	Oregon	2
Georgia	23	Pennsylvania	42
Idaho	1	Rhode Island	1
Illinois	92	South Carolina	14
Indiana	35	South Dakota	3
Iowa	47	Tennessee	29
Kansas	43	Texas	137
Kentucky	13	Utah	2
Louisiana	65	Virginia	20
Maine	6	Washington	3
Maryland	18	West Virginia	2
Massachusetts	36	Wisconsin	37
Michigan	21	Wyoming	3
Minnesota	31		
Mississippi	37	Total	1,447

Many society dinners, luncheons and smokers were held, with excellent attendance.

GENERAL RECEPTION AND ENTERTAINMENT

The local committee, true to the traditions of the South, presented an unusually interesting and attractive entertainment program. Tulane University was the host at the opening reception in the Municipal Auditorium on Monday evening, following the opening general session. Well over 800 scientists and their friends attended this delightful function.

There were daily conducted tours through the Vieux Carré by competent guides who knew the intimate histories of the various landmarks in this interesting French and Spanish section of New Orleans. A delightful tea in one or two of the beautiful old homes in this section always terminated these tours. Wives of the members of the Tulane University faculty made charming hostesses on these occasions. Numerous other social functions were complimented to the various societies and sections in attendance. These are acknowledged in the section reports. Several interesting excursions, as announced in Science for November 20, attracted considerable interest and were highly successful. Especially noteworthy excursions were those to the Teche and Evangeline Country, to the salt mines at New Iberia, to the Bonnet Carré spillway, to the plant of the Great Southern Lumber Company and to the sugar plantations.

The association is deeply grateful to the general local committee for its efficiency in carrying out the many exacting tasks which accompany the preparations for a meeting of the association and its many associated societies and consummation. The permanent secretary has heard only praise for the general chairman and his various committeemen. The permanent secretary can not be too lavish in his praise for the splendid way in which the general local committee cooperated with his office. To the members of the general committee and the sub-committees and to the local representatives of the association sections, the American Association and all the societies that met with it are deeply and lastingly grateful. The personnel of the general committee is shown below.

THE GENERAL LOCAL COMMITTEE

Albert B. Dinwiddie, *honorary chairman.*

Daniel S. Elliott, *general chairman of local committee.*

Douglas S. Anderson, *first vice-chairman of local committee.*

Andrew M. Lockett, *second vice-chairman of local committee.*

Chauncey French, *chairman of special committee on finance.*

George E. Simmons, *chairman of special committee on news service.*

Robert L. Menuet, *chairman of special committee on meeting places.*

Marten ten Hoor, *chairman of special committee on reception and entertainment.*

James M. Robert, *chairman of special committee on exhibits and equipment.*

Edward S. Hathaway, *chairman of special committee on local service.*

Robert W. Elsasser, *chairman of special committee on registration and hotels.*

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE PRESS SERVICE

(*By Austin H. Clark, director of the Press Service*)

Better than ever before, from the press view-point, was the material sent to the Press Service in advance of the New Orleans meeting. About half of those who were to present papers or addresses at New Orleans sent in copies of their manuscripts accompanied by abstracts, and about half of the remainder sent in abstracts.

There was a marked improvement both in the papers and in the abstracts submitted. Most of the papers and abstracts were sent in a form that left nothing to be desired. Furthermore, carbon copies of the programs of the sections and societies were available for dating the manuscripts much earlier than has been the case hitherto.

The natural result of the excellence of the manuscripts and of the prompt receipt of the programs was that it was possible for the representatives of the press to prepare a much greater amount of material than usual in Washington in advance of the meeting. This meant that more time was available for the preparation of the day-by-day accounts of the meeting, which were therefore of more than usual interest.

During the week before the meeting the office of the director of the Press Service in Washington was a very busy place. Three of the outstanding writers on science came down from New York, and five from Washington were in more or less constant attendance. The three from New York and two of those from Washington came to New Orleans.

The fact that in times such as the present the press was willing not only to pay the expense of sending the best writers from New York, Detroit, Washington and other northern cities to New Orleans, but also to send some of them to Washington in advance, shows conclusively that science news is now able to hold its own with news of other types.

The increasing attention paid to the meetings of the association by the press and by the people of the country imposes upon the association certain obligations. Every effort must be made to keep the section and society programs up to the highest possible standard. Especially valuable from the press view-point are invited papers by outstanding men in every line of science, and symposia in which broad problems or border line subjects are discussed from several angles.

It is essential that papers of dubious value be kept off the programs. Whatever the director of the Press Service may think, his duty is to treat all with the strictest impartiality; he can not presume to act as a censor.

Forty-one manuscripts arrived too late for use in connection with the New Orleans meeting. Many of these were excellent, and had they been received in time would have been given extensive press notice. These manuscripts were at once made available to the press, and press notices of some of them will appear in the future.

It may perhaps be mentioned that the press notices of the papers submitted in connection with the meetings are by no means all confined to a single week. During the week of the meeting only a limited amount of news can be sent out. Consequently, only the contributions of more than the average popular interest can receive attention. After the meeting is over all the remaining contributions are carefully gone over and news items taken from them continue to appear for some months, originating from the town or city in which the author lives instead of from the city in which the meeting was held. In this way every item of news value contained in the papers submitted is eventually used.

Many of the abstracts sent in without the full papers in connection with the New Orleans meeting indicated that had the complete paper been submitted an interesting press story could have been prepared from it. But the abstract alone was of little or no value.

Abstracts are useful for calling attention to the main points brought out in the papers, and for giving these points clearly and concisely. But they can not take the place of the papers themselves.

The necessary brevity of an abstract renders it too inflexible to serve as a basis for an adequate newspaper account of the subject-matter. Furthermore, most of the topics discussed in scientific papers, though they may be of popular interest if properly understood, are so remote from the average individual's personal experience as to require, for their proper comprehension, more explanatory matter than can be included in an abstract.

Many of the papers presented at the meetings are so short as to be to all intents and purposes simply abstracts themselves. To be of real value to the Press Service a paper should consist of at least ten pages, exclusive of the accompanying abstract. It would be well worth while for those giving papers to be read in five or ten minutes to send to the Press Service a manuscript about twice as long as the one which is to be read.

Each year the Press Service receives the manuscripts of a number of papers which are to be read "by title." These are sometimes of considerable interest. All such papers are considered as reports to the association and are marked for release to afternoon papers on the first day of the meeting.

The reporting of meetings would be greatly facilitated if each secretary of the sections and societies would, as soon as his program has been made up, prepare a general non-technical account of his special branch of science and send it to the Press Service. This account should be in the form of a general survey showing the present trends and indicating the advances represented by the papers to be presented.

It may be noted that nothing in regard to the papers presented at the meetings is written by the Press Service. The representatives of the press are accorded complete freedom in selecting the papers to be noticed and in writing their accounts of them. Writing for the press is a highly specialized profession, quite as specialized and difficult as the preparation of scientific papers. The function of the Press Service is to build up and to maintain a cordial feeling of mutual confidence between the members of the association and the representatives of the press. It is no part of its duties to attempt to compete with the latter.

The association was most fortunate in the choice of Assistant Professor George E. Simmons, of Tulane University, as chairman of the special committee on publicity, at New Orleans. Professor Simmons' handling of the duplicate papers sent him from Washington and of the preliminary local publicity was most effective.

The press room occupied during the meeting was excellently adapted for the work and unusually well situated, being easily accessible, and at the same time sufficiently secluded, to prevent interruptions due to unintentional intruders. The appointments of the room during the meeting left nothing to be desired.

The press representatives from outside of New Orleans who attended the meeting were: Howard W. Blakeslee, science editor, Associated Press, New York; F. B. Colton, science editor, Associated Press, Washington; Watson Davis, Science Service, Washington; Gobind Behari Lal, science editor, Universal Service, New York; William L. Laurence, *New York Times;* Leigh Mattison, science editor, International News Service, New York; Allen Shoenfield, *Detroit News;* and Dr. Frank Thone, Science Service, Washington.

It was not found practicable to present an extensive radio program in connection with the New Orleans meeting. The single radio talk, arranged for by the Press Service and Science Service acting in cooperation, was by Professor Irving Fisher, of Yale University, who discussed "Booms and Depressions" over Station WSMB on the evening of January 1.

THE SCIENCE EXHIBITION

The city of New Orleans made the gracious gesture of providing free exhibit space in the Municipal Auditorium. It is most gratifying to be able to announce that the association was able to bring to New Orleans by far the best science exhibition in the history of the association. The fact that over 15,000 persons visited the exhibition indicates its importance and interest. U. S. government bureaus, universities, scientific research institutions and scientific societies, numbering about fifty, sent one or more scientific exhibits each. Universities represented in the exhibits were Tulane University, Louisiana State University, Columbia University, Rutgers University, the Johns Hopkins University, Rice Institute, George Washington University, the University of Illinois, Fordham University and the University of Oklahoma. Other exhibitors are listed in the general program of the meeting.

In addition to this exhibition a very successful commercial exhibition of scientific apparatus and books was held in the Venetian Room of the Hotel Roosevelt, which served also as the general registration office. Several scientific instruments and pieces of apparatus were shown for the first time. Short accounts of the exhibits of the various houses which participated in this important feature of the association's work are given in the general program for the New Orleans meeting. Afternoon coffee was served in the commercial exhibition.

The members of the special committee on scientific exhibits are: F. C. Brown, *chairman*, Smithsonian Institution Building, Washington, D. C.; Owen Cattell, *secretary*, Grand Central Terminal, New York City; Austin H. Clark, U. S. National Museum, Washington, D. C.; Burton E. Livingston, Johns Hopkins University, Baltimore, Md.; Charles F. Roos, Smithsonian Institution Building, Washington, D. C.; Sam Woodley, Smithsonian Institution Building, Washington, D. C.; local representatives, J. M. Robert, Tulane University, New Orleans, La., and C. W. Heaps, Rice Institute, Houston, Texas. The commercial exhibits were again in charge of Colonel H. S. Kimberly, director of the commercial exhibition.

To the many exhibitors who made the exhibition possible, the permanent secretary is glad to express the appreciative thanks of the association.

THE ASSOCIATION PRIZE

The ninth award of the American Association prize of $1,000 was made on January 2 to Dr. C. C. Speidel, of the University of Virginia Medical School, for his paper entitled "A Study of Living Nerves," presented before Section F (Zoology) and the American Society of Zoologists. This prize is awarded annually to the author of a noteworthy contribution to science presented at the annual meeting and shown in the general program. The association is able to make these annual prize awards through the generosity of a member who prefers to remain anonymous. A list of the names of those to whom the prize has been awarded is shown below, together with the topics dealt with in the winning papers.

(1) The Cincinnati award, January, 1924. L. E. Dickson, for contributions to the theory of numbers.
(2) The Washington award, January, 1925. Divided equally between Dr. Edwin P. Hubble, for contributions on spiral nebulae, and Dr. L. R. Cleveland, for contributions on the physiology of termites and their intestinal protozoa.
(3) The Kansas City award, January, 1926. Dr. Dayton C. Miller, for contributions on the ether-drift experiment.
(4) The Philadelphia award, January, 1927. Dr. George D. Birkhoff, for mathematical criticism of some physical theories.
(5) The Nashville award, January, 1928. H. J. Muller, for contributions on the influence of x-rays on genes and chromosomes.
(6) The New York award, January, 1929. Oliver Kamm, for contributions on the hormones of the pituitary gland.
(7) The Des Moines award, January, 1930. A. J. Dempster, for contributions on the reflection of protons from a calcite crystal.
(8) The Cleveland award, January, 1931. M. A. Tuve, L. R. Hafstad and O. Dahl, for contributions on the production of beta rays and gamma rays by means of high-voltage vacuum-tubes.
(9) The New Orleans award, January, 1932. C. C. Speidel, for contributions to the study of living nerves.

The permanent secretary has prepared the following short account of the prize paper from notes supplied by the recipient, Dr. C. C. Speidel:

By a special technique, including the use of dark-field illumination, it was possible for the first time to watch directly in the living organism two fundamental activities of nerve fibers; namely, (1) the behavior of the actively moving tip of a single fiber as it grows toward the skin, and (2) the process of formation of the myelin sheath which later encases the fiber. Small frog tadpoles were used and the observations were made on the developing nerves of sensation in the transparent tail fin. While the animal was kept lightly anesthetized, a region was studied for a period of several hours. The tadpole was then replaced in pond water and the following day the same region and the same nerve fibers were again observed. In this manner the same individual fibers and sheath cells were watched daily for as long as several months.

Experimentally, many actively growing nerve sprouts may be induced if the tip of the tail is sectioned and regeneration allowed for a few days. At the tip of each sprout is an enlargement, called a "growth cone." While at rest the growth cone is rounded and smooth in contour. In action, however, a number of extremely delicate processes are continually being extended and retracted, as if the immediate vicinity is being explored for a favorable route. The growth cone advances by a slow irregular flowing motion, spinning the nerve fiber behind it. It often displays a marked tendency to follow the fibrous processes of tissue cells which it meets.

A slight temporary obstruction in the path of the growth cone may cause a small thickening, or varicosity, to be left behind. A more formidable obstruction may lead to giant cones, or to the formation of branches. Occasionally, when an insuperable obstacle is encountered, the growth cone is pinched off, and a new cone develops, which then starts its progress in a new direction.

Following the first, or pioneer, cone of growth come the second, third and later cones, each spinning a fiber of its own. As these usually adhere to the first fiber, a small nerve is thus formed. Ordinarily those grow out in the same direction, but a few cases have been seen showing that two growth cones may migrate along a nerve in exactly opposite directions at the same time, thus passing each other. Several varieties of nerve nets, or anastomoses, have also been observed in process of formation.

Subjection of the entire animal to electrical stimulation causes no appreciable effect, either on the rate or direction of growth of active cones.

As nerve fibers become more mature, many acquire a sheath consisting of a fat-like substance called "myelin." The myelin sheath protects, nourishes and insulates nerve fibers. It is formed in segments, the first ones appearing near the nerve roots. Observations on the complete process of formation of nearly 100 myelin segments show that each segment is formed through the cooperation of a "sheath cell" and a nerve fiber. Not all nerve fibers, however, are equally ripe for myelination. Those sprouts which emerge from a myelin sheath are especially ripe for myelin sheath encasement, as soon as a sheath cell arrives.

The myelin sheath is not very stable, and under conditions involving slight injury or irritation it degenerates. Many varieties of repair and readjustment of the myelin sheath have been watched. In all these a dominating rôle is played by the sheath cells. These cells exhibit exquisite sensitivity to nearby nerve injuries or abnormalities, and respond in an appropriate way to aid in the restoration of normal conditions. Under the proper stimuli they may travel in either direction along a fiber, or transfer from one nerve to another, or multiply.

Detailed histories of the stumps of sectioned nerves reveal that several varieties of nerve regeneration may be distinguished. These records afford a reasonable basis for the interpretation of the puzzling apparent "healing by first intention" of certain cut nerves.

BUSINESS PROCEEDINGS OF THE COUNCIL

The executive committee of the council met on Monday morning, December 28, and the council met in the afternoon of the same day. The council held other sessions on Tuesday, Wednesday and Thursday at 9 o'clock, and the executive committee held a session immediately following each of these council sessions. The following items of business were transacted:

1. A report of the committee on the place of science in education, presented by Dr. Otis W. Caldwell, chairman of the committee, was accepted. It was voted (a) that the chairman of the special committee write a story of the work done and prizes awarded for the newspapers; (b) that if possible the competition be repeated as soon as funds are available, and (c) that the association greatly appreciates the services of Dr. Otis W. Caldwell.

2. A report of the committee on source books in the history of the sciences, presented by Dr. Gregory D. Walcott, chairman of the committee, was accepted, with the expression of its gratification at the value of the work accomplished.

3. A report of the committee on popular science book lists, presented by Dr. Joseph L. Wheeler, chairman of the committee, was accepted, with congratulations to the committee, and especially its chairman, on the success of the undertaking.

4. Seven hundred and fifty fellows, nominated by the various sections and approved by the section committees, were elected as follows: A, 22; B, 44; C, 73; D, 25; E, 43; F, 98; G, 70; H, 27; I, 26; K, 10; L, 33; M, 159; N, 17; O, 63; Q, 50.

5. The prize committee for the New Orleans meeting was constituted as follows: Dr. G. H. Parker, *chairman;* Dr. H. C. Cowles, Dr. E. R. Laird, Dr. Harold Hotelling and Dr. C. C. Bass.

6. It was voted that it is impossible for the association to accept membership in the International Federation of Technical Agriculturists Associations, but an invitation was extended to the federation to hold meetings with the association.

7. Pi Gamma Mu (Social Science Fraternity) was accepted as an associated society.

8. It was voted that the meeting places for the next three years be definitely fixed, providing satisfactory arrangements can be made for the San Francisco meeting, as follows:

Summer		*Winter*	
1932	Syracuse	1932–33	Atlantic City
1933	Chicago	1933–34	Boston
1934	San Francisco	1934–35	Pittsburgh

9. After a discussion of policies the council voted that it favors holding the winter meeting of 1935–36 at Havana, Cuba, provided satisfactory arrangements can be made.

10. It was voted to approve the other meetings, as listed, unless unforeseen difficulties arise, as follows:

Summer		*Winter*	
1935	Minneapolis	1935–36	Havana
1936	Rochester	1936–37	Washington
1937	Denver	1937–38	Indianapolis
1938	Tentatively a Canadian city	1938–39	Atlanta or Houston

11. A committee was appointed to confer with the Patent, Trademark and Copyright Section of the American Bar Association, composed of the following members: Dr. F. G. Cottrell, *chairman;* Dr. Paul D. Foote and Dr. A. F. Woods.

12. The following were elected to emeritus life membership: Colonel David Alexander Lyle (M78, F80); John W. Cloud (M79, F86), and Rear Admiral Jefferson F. Moser (M79, F89).

13. The president of the association for 1932 was designated to represent the association on the occasion of the fiftieth anniversary of the Royal Society of Canada.

14. The audited financial reports of the permanent secretary and of the treasurer were accepted.

15. As a matter of information a brief history of the Hector Maiben Bequest, estimated at over $30,000, and progress made in settlement of the estate was presented by Dr. Henry B. Ward.

16. A request of the Southwestern Division that it be allowed to name a permanent representative on the council was referred to the executive committee for consideration and report.

17. Dr. Philip Fox was elected general chairman of the local committee for the Chicago meeting, June 19–30, 1933.

18. A report of the committee on foreign guests at the Chicago meeting was made by Dr. J. McKeen Cattell. The plans include the invitation of 75 foreign guests, and provision of $1,000 for the expenses of each.

19. Arrangements for the Atlantic City meeting in the winter of 1932–33 were discussed by the permanent secretary. He was authorized to organize the Atlantic City meeting from the Washington office.

20. It was reported by Dr. E. B. Wilson that the statisticians desired to meet with the association at Atlantic City.

21. Arrangements for the Boston meeting in the winter of 1933–34 were discussed by Dr. Karl T. Compton. The council agreed to leave these matters to be worked out by Dr. Compton and Dr. E. B. Wilson.

22. A resolution favoring the establishment of type-plant gardens of patented varieties of plants, reported from the American Genetic Association, was approved.

23. The council requested the permanent secretary to send appropriate telegrams to Dr. Franz Boas, president of the association, and to Dr. Thomas Hunt Morgan, retiring president of the association, who were absent from the meetings because of illness.

24. It was voted to change the date of the beginning of the Atlantic City meeting from December 26 to December 27, 1932.

25. Acting upon a suggestion from Captain N. H. Heck, chairman of the Secretaries' Conference, it was voted that the present method of electing fellows be suspended for one year.

26. Dr. Elder discussed the progress being made in the arrangements for the Syracuse meeting in the summer of 1932.

27. The Duren J. H. Ward project was reported to the council by Mr. Alfred Cowles, III, who reported favorably after an investigation of the project. A letter from Dr. Ward was read by the permanent secretary. After much discussion of the various policies involved, it was voted to approve the project in principle, subject to modification in details by a special committee consisting of Dr. W. B. Munro, California Institute of Technology, *chairman;* Dr. C. F. Roos, permanent secretary; Mr. Alfred Cowles, III, Colorado Springs.

28. It was voted to approve the expenditure of $300, for three emeritus life memberships, $2,000 to grantees in aid of research, and $1,000 for the committee of one hundred.

29. The report of the committee of one hundred on scientific research, as presented by Dr. Rodney H. True, the secretary, was accepted.

30. A special committee was authorized to cooperate with other agencies in improving the broadcasting of scientific programs. Dr. R. A. Millikan was named as chairman of the committee, the remaining members to be named by the chairman of the executive committee with the advice of Dr. Millikan.

31. A resolution, approved by Section H (Anthropology), favoring the establishment of a center, or of centers, for the study of the laws of growth, mature development and senile decay from the points of view of the anatomist, the physiologist and the psychologist, was adopted.

32. Officers were elected as printed in the issue of SCIENCE for January 8, pp. 41 and 42.

THE PRESIDENT ELECT

(*By W. W. Cort*)

At the annual meeting of the American Association for the Advancement of Science at New Orleans, Dr. John J. Abel, professor of pharmacology at the Johns Hopkins University Medical School, was elected president of the association for 1932. Dr. Abel is the first pharmacologist to hold this office and the third representative of the medical sciences in the last thirty years, the other two being Dr. William H. Welch and Dr. Simon Flexner. Dr. Abel's position as the foremost figure in pharmacology in this country and his long and distinguished career as a teacher and an investigator make him preeminently deserving of this great honor.

Dr. John J. Abel was born on a farm near Cleveland, Ohio, on May 19, 1857. He graduated from the University of Michigan in 1883 and spent the following year in graduate study in the Johns Hopkins University. Realizing as few men in this country did at that time the need of a broad scientific training for entering the field of medicine he spent the next seven years in studying chemistry, biology and medicine in a number of leading universities in Europe. Few men have ever had such contacts with great European leaders of the medical, chemical and biological sciences. In 1888 he received the M.D. degree from the University of Strassburg and in January, 1891, he was called to the University of Michigan as professor of materia medica and therapeutics. Dr. Abel's appointment to this professorship was a very significant event in the history of pharmacology in this country, for he was the first man to hold a full-time position in this subject, free to devote his entire time to teaching and research unhampered by outside medical practice. In 1893, at the opening of the Johns Hopkins University Medical School, he accepted the professorship of pharmacology and has held that position ever since. In fact, for the first fifteen years of his work in Baltimore he gave the instruction in physiological chemistry as well as in pharmacology. With the facilities at his command he was soon able to develop a strong department in pharmacology and was early recognized as the leader in this field in the United States. Dr. Abel retires from the professorship of pharmacology at the end of the present school year at the age of seventy-four. As stated in his request for retirement this change means to him relief from teaching and administrative duties which will give him the opportunity to devote himself more intensively to his own researches. It is particularly fitting that the retirement of such an outstanding figure in the field of medical science should be marked by such a signal honor as the election to the presidency of the American Association for the Advancement of Science.

Many have been the honors that have been heaped upon Dr. Abel during the long years of his scientific activity. He is a member of the National Academy of Sciences, the American Philosophical Society and a large number of medical, pharmacological, physiological and chemical societies in this country and abroad. In 1908 he served as president of the American Society of Biological Chemists and in 1909 and 1910 was president of the American Society of Pharmacology. Honorary degrees have been conferred on him by the University of Michigan, the University of Pittsburgh, Cambridge University, Harvard University, the University of Lwow and Yale University. In 1925 he received the first award of the Research Corporation of New York. In the same year he also held the first lectureship of the Kober Foundation of the American Association of Physicians. In 1927 he received the Willard Gibbs Medal of the American Chemical Society, and in 1928 the Chemical Foundation established in his honor at the Johns Hopkins

University the John Jacob Abel Fund for Research on the Common Cold.

Important among Dr. Abel's accomplishments has been the part he has played in the organization of societies and the founding of journals. The founding of the American Society of Biological Chemists and the American Society of Pharmacology and Experimental Therapeutics was to a very large extent due to his efforts. In 1905, conjointly with the late C. A. Herter, he started the *Journal of Biological Chemistry,* which now appears in four volumes a year. In 1909 he gave up the editing of this journal and founded the *Journal of Pharmacology and Experimental Therapeutics,* which he still edits in association with Dr. Dixon of Cambridge. The high standards he has set as editor of these two journals have greatly influenced the quality of publication in these fields in the United States. In recognition of this and of his important research contributions, Volume 29 of the *Journal of Pharmacology and Experimental Therapeutics* was dedicated to him in 1926 by his friends and pupils.

It is difficult even to mention in the brief space of such an article as this Dr. Abel's research contributions to the fields of biochemistry and pharmacology. He is probably best known for his physiological and chemical studies of the products of internal secretion known as hormones. In 1895 he began work on the isolation of the hormone elaborated in the medullary portion of the suprarenal gland which has such an extraordinary action in raising the blood pressure. A number of years were devoted to this problem with the result that the active principle was obtained in the form of a monobenzoyl derivative to which Dr. Abel gave the name epinephrine. This led to the discovery of the free base, adrenaline, by Takamine. This pioneer work has been followed by literally thousands of papers by other investigators on the physiological action, chemical constitution and medical uses of this product. Later, 1906 to 1908, he succeeded in isolating the poisonous principles of the deadly mushroom, *Amanita phalloides.* Later came the period of research on vividiffusion, during which he devised a method by which the blood from a living animal can be deflected from the body, passed through a dialyzing apparatus and then returned to the body. The most recent of Dr. Abel's major achievements and in many ways the most important was the isolation of the pancreatic hormone, insulin, as a crystalline compound. This discovery not only has great medical importance, but is the first example of the isolation of an internal secretion product that must be classed with the proteins.

Important as Dr. Abel's researches have been in the fields of biochemistry, pharmacology and therapeutics, perhaps even a greater contribution has been his influence on the large group of investigators who have gone out from his laboratory to win distinction in many parts of the world. Many of the most important positions in the field of pharmacology in this country are held by men who were at one time his associates or students. Investigators have come from foreign countries to sit at his feet and have returned with new knowledge and enthusiasm. His efforts are, therefore, being multiplied many fold by the work of his students and his students' students.

Dr. Abel has always worked on difficult fields and has never chosen the easy, obvious lines of research. He has never followed the prevailing currents in his subject but has been the one to start new currents. He has emphasized the broadness of pharmacology, and by example and instruction has urged his students to choose their own problems and follow them wherever they might lead. His point of view has in this way broadened the whole field of pharmacology, and has emphasized constantly its fundamental relationship to chemistry and biology. Dr. Abel has never subordinated his associates and students to his own work, but has constantly urged them to find and follow out their own problems. As a technician he is probably unsurpassed in the manipulation of minute quantities of chemicals. For Dr. Abel his scientific research is not only his day's work but also his recreation and religion. He has allowed nothing to disturb the continuity of his research effort and now that he is retiring from his teaching and administrative duties he has already planned for his future investigations problems enough for a lifetime of work. So in the newly elected president of the American Association for the Advancement of Science we have not alone an eminent representative of the medical sciences, but a man who exemplifies perhaps as well as any one in the world the highest ideals of scientific research.

SESSIONS OF THE SECRETARIES' CONFERENCE

(Report from P. E. Brown)

The Secretaries' Conference and complimentary luncheon were held in New Orleans, on Monday noon, with Mr. N. H. Heck presiding. Thirty-nine secretaries or representatives and members of the executive committee were in attendance. The method of election of fellows by the association was the chief topic considered, the discussion being led by Dr. George T. Hargitt, who suggested some modifications of the present plan, in order to avoid some of the present difficulties. It was deemed necessary that the subject receive further careful study before any definite recommendations could be made, and the chairman was authorized to appoint a special committee to consider the entire fellowship problem and report by June 1, 1932. The organization for the summer meetings was also discussed and the appointment of a special committee to study and report on this matter was authorized. The chairman of the conference for 1932 is Mr. N. H. Heck, secretary of Section M, and the secretary is Professor P. E. Brown, secretary of Section O.

THE GENERAL SESSIONS

The series of five evening lectures held at the Municipal Auditorium were by far the best attended lectures in the history of the association. These lectures, designed for the general educated populace of the host city and for scientists in all fields of scientific endeavor, encourage the cultivation of the broader aspects of scientific thought and the interchange of ideas between the several groups of men and women of science. Men of the highest eminence presented these addresses in non-technical language in such a way that they were of maximum benefit to laymen and scientists in other fields of work. The following brief reports are based on notes supplied by Science Service.

Dr. Richard P. Strong, of Harvard University, who gave the first of the evening lectures, declared that a tropical scourge, afflicting descendants of the Maya now living in coffee-growing highland regions of Guatemala, can be wiped from the face of the earth by surgical treatment to remove unsightly tumors and isolation of infected inhabitants who have not yet developed tumors. A single kind of fly, known as the coffee fly, which is related to the turkey gnat of the southern United States, is the intermediate host or transmitter of this disease. When a coffee fly bites a sufferer from the disease, it is infected with one stage of the worm, *Filaria onchocerca,* which causes the disease. The worm undergoes a certain development in the fly and is then passed on to a well person bitten by the fly. The plague of the fiery serpents that afflicted the Hebrews in the wilderness (chapter 21 of Numbers) was caused by the oldest known parasitic worm, *Filaria medinansis,* which is a common affliction in Bible lands and India to-day. Dr. Strong also described a number of other Filariae.

Application of the methods of science to every-day affairs to bring the world out of its state of economic upheaval was urged by C. F. Hirshfeld, who addressed the Society of the Sigma Xi at the joint meeting with the association on Tuesday evening. He declared that in the fields that are generally designated as political, social and economic we still proceed largely upon the basis of tradition, expediency, sentiment, almost anything except determined fact. "The blame for such a situation appears to lie directly upon the shoulders of those who have been content to use the research method in their own narrow fields to cause world-stirring changes without giving thought to the collateral products of their work and without recognizing their responsibilities in connection therewith." Until the research method is applied to the social sciences "the world must continue to utilize one expedient after another as temporary palliatives and to be subject to frequent serious and lamentable upheavals which serve as temporary outlets for pent-up, unbalanced stresses."

Wednesday evening was given over to a memorial program to Thomas Alva Edison, who was one of the founders of the association's official journal, SCIENCE. Dr. R. A. Millikan, in speaking on Edison as a scientist, said: "During the war, when we were both engaged in Washington, I spent an evening or two with him. He was then, at the age of seventy and more, reading some of the newer books that were then appearing in the field of pure science, and asking intelligent questions about them, too. His ears were gone, but there had been no crystallizing of his mind." Dr. Karl T. Compton told about Edison's laboratory in war-time. He described several search-and-trial methods used by Mr. Edison, but concluded by saying: "It is a mistake, however, to think that all Edison's work was carried on by the search and trial method. Back of everything which he did or tried there was always an idea. The starting point was always the need of accomplishing some purpose, the second stage seemed to be the suggestion of various ways of accomplishing that purpose, and the final stage consisted in trying out these suggested solutions in as thorough and systematic a manner as possible in order to find the best." Dr. Frank B. Jewett, vice-president of the American Telephone and Telegraph Company, gave an account of some of Edison's important contributions to industry and civilization. Dr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston, gave an appreciation of Mr. Edison, based on personal acquaintance. These tributes were printed in the issue of SCIENCE for January 15.

On Thursday evening Dr. Floyd A. Nagler, of the University of Iowa, declared that engineers, who two centuries ago first attempted to master the Mississippi, should have begun at Cairo, Illinois, where the lower Mississippi begins, and not near New Orleans, where the river nears the Gulf of Mexico. "If engineers had started at Cairo with their dikes and levees and proceeded downstream, the folly of trying to exclude the Mississippi from all the surrounding plain would have been apparent. The problem has been made one of flood protection, whereas it should be one of flood passage."

On Friday evening Professor Irving Fisher declared that wide-spread liquidation, such as has been going on in this period of depression, does not have the intended effect of reducing debts but increases them in the sense of making every unpaid dollar more burdensome. Even the most discreet and conservative business men have greater burdens of debt forced upon them by the distress selling of enormous quantities of collateral and all other forms of securities, which deflates prices of things sold and wipes out currency. In 1925 Great Britain became bound to the United States in the sum of $4,600,000,000 and by punctiliously keeping up interest and reduction of principal now owes $4,425,000,000. It would seem that her debt has been reduced, but Professor Fisher contended that, due to the bloated dollar of to-day, Britain now owes us $6,700,000,000 in terms of the dollar of 1925. Much of the present trouble can be traced to our failure to understand that money is a mechanism that can get out of order, inflations with their booms and deflations with their depressions.

On Tuesday afternoon, at a joint session of the association with the mathematical societies, the ninth Josiah Willard Gibbs lecture was delivered by Professor P. W. Bridgman, of Harvard University, on the subject "Statistical Mechanics and the Second Law of Thermodynamics." The speaker presented some very interesting interpretations of the bearing of statistical mechanics, in its present stage of development, on certain fundamental notions of physical theory. He offered a refutation of some of the contentions of Eddington and Lewis with regard to the nature of time, namely, Eddington's idea as to the increase of entropy being the determining feature in deciding the direction of time flow and Lewis's ideas on the symmetry of time in physics. The address as a whole emphasized the limitations, as well as the usefulness of the methods of statistical mechanics.

A number of important general sessions were held in the afternoons under the sponsorship of various sections. Accounts of these are given in the sectional reports of scientific sessions.

THE SCIENTIFIC SESSIONS

The following accounts of the sessions of the sections and societies[1] that met simultaneously with the American Association this year have been prepared by the permanent secretary from reports furnished by the several section and society secretaries as indicated. They are arranged according to the association sections. Several societies are shown as related to both the zoological and botanical sections, and another group is related to all sections. Reports were requested from the secretaries of all organizations shown in the general program of the New Orleans meeting, and almost all responded.

SECTION A (MATHEMATICS). **AMERICAN MATHEMATICAL SOCIETY. **MATHEMATICAL ASSOCIATION OF AMERICA

(*Report from C. N. Moore and W. D. Cairns*)

On Tuesday Section A joined with the American Mathematical Society and the American Physical Society in a joint program presented by leading representatives from the mathematical and physical groups. Professor G. D. Birkhoff gave an exposition of some of his recent important researches on stability and instability in physical systems. Physical systems, obeying a law of uniformity expressed by a set of differential equations, were classified as of three main types: (a) non-recurrent, (b) recurrent and (c) variational. In the non-recurrent case, illustrated by the motion of a particle in a line subject to an arbitrary law of force, the motion is always (in the sense of probability) in the immediate vicinity of the "central motions" previously defined by Professor Birkhoff, which form a recurrent set of motions. In the recurrent case, when there is an invariant integral and a closed manifold M of states of motion, a certain recurrence theorem and the "ergodic theorem," recently established by the speaker, are fundamental. The outstanding and extremely difficult problem here is to determine the type of transitivity which holds, and in particular whether a given system is strongly transitive in the sense of Hopf. The variational systems derived from a variational principle are also recurrent if the manifold is closed. Here the ergodic function $T(\epsilon)$, in which T is the least time required for any motion to pass within distance ϵ of all points of the manifold, is a fundamental notion. Distinctions between different types of variational systems are made on the basis of the rate of increase of $T(\epsilon)$ as ϵ decreases.

Dr. W. F. G. Swann discussed the relationship of the various wave mechanical theories. He maintained, in particular, that although it is customary to retain the idea of a particle electron in the language of the theory, the theory itself makes no logical use of such entities. Its story must be regarded as complete without them. A similar remark may be made as regards the photon, considered as a light corpuscle. The properties of protons and electrons, as thought of a few years ago, have become matter foreign to the future of the wave mechanical concepts; and to try to force them into a permanent place in telling the story of atomic phenomena is like trying to base the discussion of the water motions of a rough sea upon the motions of the ships which are tossed about in it.

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[1] Officially associated organizations that are affiliated with the American Association are designated by one or two asterisks (showing that they each have one or two representatives in the association council, respectively). Other officially associated organizations are each designated by a dagger.

Dr. Swann also discussed Heisenberg's principle of indetermination and the deterministic view of the universe. He pointed out that the question of whether we should describe the answers in terms of laws of causality, or partly in terms of laws of chance, is to some extent a matter of choice. It is always possible to describe any sequence of events over a finite time in terms of the laws of causality, but a description in terms of the laws of chance may be more convenient, and simpler. We must remember that we can not claim that one theory of the universe is right and all others wrong. There may be many which fit the same observed facts.

Finally, issue was taken with the customary conclusion to the effect that the laws of probability demand the so-called heat death of the universe. It was pointed out how phenomena leading to other conclusions could exist, and yet be of such a nature as to have permitted us to go through in our world exactly the mental development we have gone through. In spite of the existence of such phenomena, we could have discovered the second law of thermodynamics, could have invented the statistical theory of thermodynamics and have been tempted to extrapolate our conclusions to the belief that the phenomena in question were impossible. (See the report of Section B.)

The afternoon program was opened with the address of the retiring vice-president for Section A, Professor G. A. Bliss. This address dealt with various mathematical methods that have been used in the quantum theory, particularly those that belong in the field of the calculus of variations and related mathematical theories.

The ninth Josiah Willard Gibbs lecture was delivered by Dr. P. W. Bridgman on Tuesday afternoon. (See "General Sessions.")

The feature of the Wednesday morning program of the American Mathematical Society was the presentation of the Cole Prize in the theory of numbers to Professor H. S. Vandiver for work on Fermat's Last Theorem. He responded to the award by giving an interesting account of the advances he has made toward a complete discussion of this famous problem, which has intrigued the mathematical world for nearly three centuries.

The following officers of the American Mathematical Society were elected: *Vice-presidents,* Professor E. W. Chittenden and H. H. Mitchell; *secretary,* Professor R. G. D. Richardson; *treasurer,* Professor G. W. Mullins; *associate secretaries,* Professor M. H. Ingraham and Professor T. M. Putnam; *member editorial committee of the Bulletin,* Professor W. R. Longley; *member editorial committee of the Transactions,* Professor J. D. Tamarkin; *member editorial committee of the American Journal of Mathematics,* Professor A. B. Coble; *member editorial committee of the Colloquium Publications,* Professor R. L. Moore; *members of council,* Professors C. R. Adams, Arnold Emch, T. R. Hollcroft, C. C. MacDuffee, W. E. Milne, E. H. Moore.

On Thursday morning there was a joint session of the American Mathematical Society and the Mathematical Association of America, at which Professor E. R. Hedrick, representing the former organization, delivered his retiring presidential address, entitled "Non-Analytic Functions of a Complex Variable." The speaker first reviewed the history of efforts that have been made to extend the field of application of the classical theory of functions of a complex variable. These various generalizations include the extension to functions of several complex variables, the functions of hypercomplex number systems, the functions of variables on surfaces or in n-dimensional spaces and functions defined on special sets of points. Other forms of generalization include those that generalize the fundamental differential or integral equations that are connected with the classical theory. He emphasized that many fundamental theorems of the classical theory, such as the mean-value theorems, the Morera theorems, the Liouville theorems and theorems of certain specified types, hold good also for the functions here discussed.

On Thursday afternoon Section A joined with Section K to listen to an interesting paper by Professor E. B. Wilson and Miss Ruth R. Puffer on "Laws of Population Growth." (See the report of Section K.)

In addition to the above-mentioned special features, the American Mathematical Society held sessions on Monday morning, Monday afternoon and Wednesday morning for the presentation of contributed papers. A joint dinner for all mathematicians present was held on Wednesday evening at the Patio Royal Restaurant.

At the joint meeting of the Mathematical Association of America with the American Mathematical Society on Thursday morning, Professor R. D. Carmichael, of the University of Illinois, gave an extended summary of recent research work in the theory of numbers; this excellent paper will appear in the *American Mathematical Monthly.* The Mathematical Association also held a separate session on Thursday afternoon. Professor C. R. Sherer, of Texas Christian University, gave an account of a method for the conduct of freshman mathematics courses whereby he made manifest that there was a distinct gain in efficiency. Professor Otto Dunkel, of Washington University, extended to various integrals a process of substitution involving "proportion by composition," which is used occasionally in only one special elementary integral. Professor Dunham Jackson gave the outline of a course in Fourier Series as he has presented it to a class which combines first-year graduate students along with students who have had just one year of the calculus. This kind of a course will make possible a grasp of the method of Fourier Series at an earlier stage than is usual in collegiate or graduate mathematics. At the annual business meeting Professors W. H. Bussey and G. C. Evans were elected vice-presidents for 1932, and Professors H. E. Buchanan, W. B. Ford, E. R. Hedrick and W. R. Longley were elected members of the board of trustees for three years. Professor W. B. Carver, of Cornell University, has succeeded Professor Bussey as editor-in-chief of the *Monthly*.

SECTION B (PHYSICS). **AMERICAN PHYSICAL SOCIETY. *AMERICAN METEOROLOGICAL SOCIETY. **AMERICAN ASSOCIATION OF PHYSICS TEACHERS

(*Reports from A. L. Hughes, E. Allan Aime and Glen W. Warner.*)

The meeting of Section B was presided over by Professor Bergen Davis, of Columbia University. The meeting opened with the address of the retiring vice-president, Professor F. K. Richtmyer, on "The Romance of the Next Decimal Place."

He pointed out that the ever-increasing precision with which the physicist measures physical quantities is one of the important factors in the rapid strides which physics has made in recent decades. The hunt after "the next decimal place" has not only made possible more exact statements of physical laws, but in very many instances has led to new discoveries. Tycho's accurate observations of the motion of Mars led Kepler to deduce the elliptical nature of the planetary orbits, which in turn played an important part in the establishment of Newton's law of gravitation. Foucault's accurate measurement of the velocity of light was the clinching argument for the wave theory. The relatively exact establishment of the empirical laws of black body radiation provided the foundation on which Planck built the quantum theory. Lord Rayleigh's dissatisfaction with the slight lack of agreement between the density of nitrogen obtained from the air and that prepared chemically led to the discovery of argon and other noble gases whose existence had not been suspected. Time and again new avenues in physics have been opened up as a result of increasing the precision of experimental measurements. In fact, a new discovery is so likely to result from increased precision that the physicist might adopt as his dictum, "Look after the next decimal place and physical theories will take care of themselves."

The second paper on the program of Section B was an invited address on "Solar Radiation as a Meteorological Factor," by Dr. Herbert H. Kimball, of the United States Weather Bureau. The variations in the heat received from the sun at any one point of the earth's surface depend on several factors. The chief of these are: (1) Variations in the distance of the earth from the sun according to the time of the year; (2) variations due to solar declination, which causes seasonal variations which are small at the equator and increase rapidly as we go to the poles; (3) variations due to the changing dust content (due to volcanic eruptions) of the atmosphere; and (4) variations in the rate of emission of heat from the sun itself. Dr. Kimball reviewed the evidence for concluding that the weather changes are not brought about as the direct result of the slight changes in the solar radiation as outlined above, but are due almost entirely to the huge differences in the intensity of the solar radiation received by the earth in the equatorial and polar regions. Gravity causes the heavy cold air to displace the lighter warm air at the surface, and a polar-equatorial circulation is set up, turbulent in character, especially in winter, when the temperature differences are most marked. It is to studies of this turbulent polar-equatorial movement of air that meteorologists look for improvements in weather forecasting. It is becoming more clearly recognized that the atmospheric processes in the polar region of both hemispheres play a predominant part in determining the weather changes. The next step forward in weather forecasting will call for the establishment of well-equipped meteorological stations as far north as possible.

Dr. W. F. G. Swann, the president of the American Physical Society, chose as the subject for his presidential address, "Reality in Physics." The lecture began with a review of what constitutes an acceptable theory. One that is satisfactory to a mathematician may appear to be quite unconvincing to a certain type of physicist. To the former, the development of a scheme of mathematics in which there is a one-to-one correspondence between certain things in the mathematics and the observable phenomena of nature constitutes a satisfactory theory. The postulates of his mathematics become the laws of nature in physics. The unsophisticated physicist will not quarrel with such a theory insofar as it correlates phenomena and predicts new ones, but he may feel very dissatisfied with the absence of a model or mental picture of the processes. He demands not only that a theory should work, but that it should be reasonable. The reasonableness of the theory is associated in his mind with its reality. To him there is reality in an explanation of a physical process if he can simulate it by means of a model involving familiar things, such as wheels, springs, weights. A closer analysis, however, shows that, after all, reality is a matter of feeling; it is something which satisfies our undefined sense of the fitness of things. The Bohr picture of clear-cut electron orbits within an atom has now been replaced by a set of rules which give the same quantitative results. Thus the theory has been stripped down to essentials, while the superimposed, but superfluous, orbit picture, which in the minds of many gave an impression of reality to the theory, has been discarded. Yet models have proved time and again of the greatest assistance in interpreting and stimulating research; it would be foolish to ban them. They should, however, be recognized for what they are; namely, stimulants to thought and not an essential part of a theory. Reality "has no existence outside your own dreams and is often no more than the reflection of your own thoughts shining on the face of nature." (See the report of Section A.)

The remainder of the program of the American Physical Society was made up of three parts. First, there was the regular program of contributed papers, in which forty-nine reports were presented. Next there were two joint meetings with Section A and the American Mathematical Society. (See the report of Section A.)

It was particularly fitting that a joint meeting of the American Physical Society and the Society of Petroleum Geologists should be held at the New Orleans meeting, for many of the successful applications of geophysics have been made in Louisiana and Texas. (See the report of Section E.)

A successful dinner of the American Physical Society and of the American Association of Physics Teachers was held at the Roosevelt Hotel on December 30.

Dr. John Patterson, president of the American Meteorological Society, discussed in a most interesting and instructive manner the methods now used in the reduction of the barometer to sea-level, and pointed out the fact that in elevated regions the corrections applied are often in error.

Mr. Harvey S. Cole presented material on his study of the droughts in Arkansas covering a 32-year period.

Mr. Lawrence H. Daingerfield discussed weather and cotton yield in Texas and in conclusion said: "It is quite obvious from this study that purely weather factors alone, which might have produced a fair or reasonably good crop in the early years, under happier conditions or better soil and fewer battling pests, may well produce an extremely short crop due to new factors or hazards at the present time."

Mr. W. F. McDonald indicated that a system of wind force terminology referring wind velocities to aircraft movement is much more desirable than the Beaufort system now used, which was designed primarily for use in connection with seagoing vessels. Dr. Isaac Monroe Cline pointed out that under the spiral inward circulation theory, relative to the wind directions in cyclones, it is generally held that waves and swells were sent out from the cyclone center with considerable uniformity in all directions. This, however, is not true. The storm tide is built up on the coast line only directly in front of and to the right of the line along which the cyclonic center is advancing. Professor W. J. Humphreys presented two papers, "Sunshine *versus* Starshine" and "Shower and Drizzle." In the former he corrected some common errors regarding the "temperature of space," and exhibited a method for determining the absolute temperature of an object placed in space at the distance of the earth from the sun. Mr. Charles D. Reed showed that in many cases marked weather abnormalities of midwinter and midsummer persist over periods of 60 days or more, and that monthly forecasts could be made, based upon these abnormalities.

Dr. Herbert H. Kimball said that the meteorological work in connection with the polar year 1932-33 is expected to produce results of immediate practical value in forecasting weather in middle latitudes. A network of stations north of latitude 55° is to be maintained from August, 1932, to August, 1933, inclusive. Most of these will be in wireless communication with the meteorological services of the northern hemisphere, so that observations can be entered at once on northern hemisphere weather maps. A similar system on a smaller scale is planned for the south pole. The dynamical interaction between polar and equatorial air currents in middle latitudes will be studied.

Mr. Eric R. Miller presented a paper giving an account of the work being done at the German National Flying Stations. A trained meteorologist is attached to each ship to further the interests of experimental and research meteorology and to test aeronautical instruments. Thunderstorms, icing of airplanes, oxygen breathing apparatus, atmospheric electricity, aerial photography and the sports of gliding and soaring are all made subjects of special study.

Mr. Grady Norton declared that the lack of an intensive weather reporting service by teletype and radio broadcast places much of the burden of advising aviators upon the forecasters.

The annual reports of the secretary and treasurer showed that the society continued to grow in membership during the year 1931 and that it was in sound financial condition. The following officers were elected: Dr. Herbert H. Kimball, *president;* Mr. Henry B. Hersey, *vice-president;* Dr. Charles F. Brooks, *secretary;* Mr. W. R. Gregg, *treasurer;* and Mr. Robert E. Horton, Professor Alexander G. Mc-

Adie, Mr. Charles L. Mitchell, Mr. Julius M. Sherier and Mr. Melvin B. Summers, *councilors*.

The program of the first annual meeting of the American Association of Physics Teachers included discussions of three main topics: (1) "The Introductory Course in College Physics"; (2) "Research and Project Work for Undergraduates"; (3) "Special Topics." Dr. C. J. Lapp gave the plan of the correlated science course for liberal arts students at the State University of Iowa. The subject-matter consists of approximately equal amounts of physics, chemistry, botany, zoology, geology and astronomy, presented in the order named by teachers from the various departments. Professor Lapp emphasized the experimental nature of the course and the problem of proper selection of subject-matter. He recommended that such a course should take the time of sixteen semester hours.

Professor A. A. Knowlton, in describing the cultural course in general physics at Reed College, emphasized the necessity for making the course attractive and interesting, but without neglect of the fundamentals. He recommended a very liberal amount of the new physics interwoven with the classical, a unified treatment rather than the traditional subdivisions, and a normal amount of mathematics with emphasis on the physical interpretation of the formulas used.

Professor Harvey B. Lemon outlined the new physical science program of the University of Chicago and described the 200-page syllabus prepared for use of students and the museum of self-operating experiments.

The general discussions showed many conflicting opinions, but it was unanimously agreed that too much is being expected of students of general physics, and far too much subject-matter is being included. At the business session a permanent constitution and by-laws were adopted and plans were perfected for promoting investigations in physics education.

SECTION C (CHEMISTRY)

(*Report from C. A. Browne*)

Section C of the American Association for the Advancement of Science held its meetings on the forenoons and afternoons of December 29 and December 30. Owing to the resignation of the secretary of the section, R. R. Renshaw, the duties of this office were filled by the chairman, C. A. Browne. Professor C. E. Coats, of the Louisiana State University, presided over the session of Tuesday morning, and Professor H. W. Moseley, of Tulane University, over that of Tuesday afternoon. There was an average attendance of about fifty at the different sessions.

A session devoted to general papers was opened by the address of the retiring vice-president, Professor James F. Norris, of the Massachusetts Institute of Technology, upon "Research and the Development of Industrial Organic Chemistry." In the absence of Professor Norris, his address was read by Dr. C. A. Browne. A paper upon "New Aspects in the Feeding of Cottonseed Products" by Dr. H. Stevens and Dr. E. M. Nelson, of the U. S. Bureau of Chemistry and Soils, was read by Dr. W. W. Skinner. Interesting experiments upon the synthesis and isolation of Crystalline Vitamin D were described by Dr. C. E. Bills and Dr. F. G. McDonald, of Mead, Johnson and Co. New information upon the crystalline forms of glycine was presented by Dr. T. S. Eckert, of Birmingham-Southern College. An improved method for making spontaneous emulsions for insecticidal purposes and a new analytical procedure for determining the mineral oil on leaf surfaces after spraying were described by Dr. L. H. Dawsey, of the U. S. Bureau of Chemistry and Soils. An account of chemical observations in foreign lands, illustrated by lantern slides, was given by Dr. C. A. Browne.

The program for a session devoted to a symposium upon "Recent Developments in Some of the Agricultural Chemical Industries of the South" comprised papers by Dr. Gipson Carter, of Louisiana State University, Dr. S. A. LeCroy, of Louisiana State University, Dr. F. H. Thurber and Dr. H. S. Paine, of the U. S. Bureau of Chemistry and Soils, Dr. C. F. Walton, Jr., of the U. S. Bureau of Chemistry and Soils, Dr. F. P. Veitch, of the U. S. Bureau of Chemistry and Soils, Dr. David Wesson, of Montclair, N. J., and Dr. R. H. Stevens, of the Bogalusa Paper Company. The contributors to this symposium called attention to the vast number of possibilities awaiting development in the chemical industries of the South, such as ramie, sweet potato, starch, sirup, naval stores, cottonseed and paper manufacturing. The papers awakened a wide discussion among the members of the section.

Two sessions were devoted to a symposium upon "Some of the Normal and Abnormal Components of the Atmosphere." Contributions to this symposium were made by Professor J. Willard Hershey, of McPherson College (with a 12-minute film); Dr. W. J. Humphreys, of the U. S. Weather Bureau; Dr. J. E. Ives, of the U. S. Public Health Service; Dr. W. W. Skinner and Dr. S. W. Griffin, of the U. S. Bureau of Chemistry and Soils, and Mr. R. W. Frey, of the U. S. Bureau of Chemistry and Soils. There was a general discussion upon the biological, agricultural, industrial and economic significance of various components of the atmosphere. The enormous losses which are produced annually in the United States by gaseous and other pollutions of the atmosphere were particularly emphasized, and it was the general opinion of the section that the problem of curtailing these losses and the injury to public health and to plant and animal life was one of outstanding importance.

On Thursday afternoon Section C joined with Sections I (Psychology) and N (Medical Sciences) for a symposium on "New Methods of Approach to Problems of Mental Disorders." (See the report of Section N.)

SECTION D (ASTRONOMY)

(*Report from Philip Fox*)

The American Astronomical Society held a meeting in Washington from December 28 to 30. This meeting was followed by a meeting of the American Section of the International Astronomical Union in preparation for the first American meeting of the Union in 1932. The attendance of astronomers in New Orleans was therefore small; only a score were present at the one session of Section D to discuss the seven papers presented.

Mr. M. R. Ensign and Dr. B. F. Dostal contributed a preliminary paper toward the interpretation of the complex record of temperature, barometric pressure, direction and location of storm tracks, attempting to associate them with sunspot phenomena, planetary periods and lunar declinations.

Dr. H. T. Stetson continues his investigation of the relation of solar activity and intensity of radio reception. With a 50 per cent. diminution of spot numbers, the intensity of radio signals has increased 400 per cent. This is interpreted as due to change of level of the Kennelly-Heaviside layer in response to electronic emission from the sun as modified by the fields of sun-spots.

Mr. Richard Zug and Dr. D. W. Morehouse have investigated the Dark Ring configuration in the Labrador region of the North American Nebula on plates made at the Drake Municipal Observatory. From counts which include 3,373 stars within, on and about this ring they find evidence of absorbing clouds at the levels of the 11.5 and 15.5 magnitude stars.

Observations from many stations on the brilliancy of the advance guard of the Leonid meteoric shower in 1930 and 1931 indicate a prospect for a rich display in 1932. Dr. C. C. Wylie and assistants from three stations at the corners of a triangle, roughly thirty miles on a side, on November 17, observed meteors at the rate of two per minute per person and obtained data for derivation of the paths. Similar teams organized for observation in November, 1932, should obtain valuable results.

Many stars of class B_e show emission lines of singly ionized iron. Because the ionization and excitation potentials of iron are low, Otto Struve examined on Yerkes Observatory spectrograms of B_e stars the lines of other elements of comparatively low ionization and excitation potentials. He found emission lines of ionized magnesium, silicon and other elements. He further made some interesting observations on the width of the emission lines as follows:

	H	F II	Mg II
Chi Ophiuchi	2.5 A	4.1 A	5.7 A
Gamma Cassiopeiae	3.9 A	4.5 A	6.6 A

He concludes that the broadening is due to the rotation of stratified shells or rings of gas about the star, the lines of greater width having origin in lower rings moving, in accordance with Kepler's laws, at higher speeds.

A paper by Mr. C. S. Beals described a new photoelectric microphotometer built at the Dominion Astrophysical Observatory. It is a direct reading instrument, sensitive, flexible and for many purposes faster and more convenient than the self-registering types. The sensitivity can be varied and can be made to give a deflection of 50 mm on the galvanometer scale for the smallest difference of density clearly perceptible to the eye. Curves of the Wolf-Rayet band at 4686 in the spectrum of HD 192163 revealing a complex structure and curves of contours of the inter-stellar calcium lines of 9 Camelopardalis show the accuracy and range of applicability of the instrument.

The final paper was a report on the W. J. McDonald Observatory to be established under the trusteeship of the Board of Regents of the University of Texas. The $800,000 available as of April, 1930, may be allowed to accumulate or be used in immediate construction. Any part of the sum may be used for endowment. Action will be deferred until the advice of eminent astronomers has been secured. Meanwhile thorough tests of promising sites will be conducted. The site must not necessarily be in Texas but preferably so. Present opinion seems to be to proceed with construction when type of observatory equipment and its site are determined.

The address of the retiring vice-president, Dr. D. W. Morehouse, presented at a general assembly, has been printed in full in SCIENCE for January 8.

SECTION E (GEOLOGY AND GEOGRAPHY). **GEOLOGICAL SOCIETY OF AMERICA. SOCIETY OF PETROLEUM GEOPHYSICISTS

(*Reports from Kirtley F. Mather and John F. Weinzirl*)

Section E held two sessions on Friday, in conjunction with the Geological Society of America. None of the other associated organizations related to this section were in session in New Orleans, and the principal meeting of the Geological Society of America was held in Tulsa, Oklahoma, from December 29 to 31, but about fifty geologists and geographers attended the joint sessions in New Orleans and ten papers were listed on the program. Professor Douglas Johnson, of Columbia University, vice-president for the section, presided. The address of the retiring vice-president, Professor Edson S. Bastin, of the University of Chicago, was presented at the afternoon session. It dealt with the types of copper deposits low in sulphur and iron. Abstracts of all papers presented will be published in the March issue of the *Bulletin of the Geological Society of America.*

About thirty of the geologists and geographers who were present in New Orleans gathered at Galatoire's for dinner on Friday evening. An unusually interesting feature of the New Orleans meeting was the field trip to the salt domes and mines of the Teche country. The party left New Orleans on Friday evening and spent much of Saturday in the field. The thanks of all in attendance are due to Professor Steinmayer and his colleagues for the excellent arrangements which they had made for the technical sessions and the field trip.

A joint meeting of the Society of Petroleum Geophysicists, American Physical Society and Section E was held on Wednesday afternoon.

Under the able guidance of Dr. Eckhardt the meeting developed into a happy combination of theoretical and practical discussion of different matters presented. Discussion brought forth by Dr. Donald C. Barton, Dr. E. E. Rosaire and Mr. Eugene McDermott painted a vivid picture of the immediate commercial application of geophysics in oil field exploration. A noteworthy theoretical paper was presented by Mr. Maurice Ewing, entitled, "Earth-Amplitudes in Seismic Prospecting." Papers showing much study on the accumulated data of the last years of commercial geophysical exploration were presented by Dr. H. A. Wilson, Mr. F. A. Snell, Mr. H. Rutherford and Dr. M. M. Slotnick.

The meeting reflected the beneficial effects of the protracted cession in helter-skelter geophysical exploration of late years. Time has been allowed those in the commercial world to rework accumulated data, devise new formulae, improve upon instrument construction and, of greatest importance, improve upon the interpretation of existing information in hand for better evaluation of future work.

SECTION F (ZOOLOGICAL SCIENCES). **AMERICAN SOCIETY OF ZOOLOGISTS. **ENTOMOLOGICAL SOCIETY OF AMERICA. **AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS. **AMERICAN SOCIETY OF PARASITOLOGISTS. †WILSON ORNITHOLOGICAL CLUB

(*Reports from Wm. H. Cole, J. J. Davis, A. F. Burgess, Norman R. Stoll, and Jesse M. Shaver*)

The American Society of Zoologists held sessions for the reading of papers on Tuesday morning, Wednesday morning and Wednesday afternoon. Exclusive of joint sessions and the invitation program, fifty papers were read, distributed as follows: physiology, 34; embryology, 4; cytology, 6; protozoology, 2; miscellaneous, 4. Six papers were contributed to the joint session with the American Society of Parasitologists, and two to the session with the Ecological Society of America on Tuesday and Wednesday mornings. Tuesday afternoon was devoted to the informal presentation of fourteen demonstrations and exhibits. One hundred and four other papers were presented by title only. At the regular sessions the attendance was good, over one hundred being present at the Tuesday morning session on physiology, and from 35 to 75 at the other sessions. All the above sessions and demonstrations were held at Tulane University, where the appointments and facilities were excellent. Invitational research papers were presented on Thursday morning in the Municipal Auditorium by Dr. C. E. McClung, Dr. G. H. Parker, Dr. H. V. Wilson, and Dr. F. R. Lillie. This session was highly successful, with over 150 in attendance. In the afternoon a joint session with the American Society of Naturalists was held in the same room and was also well attended.

On Friday an eight-hour field trip to the Pearl River region, northeast of New Orleans, was conducted for zoologists by the departments of botany and zoology, of Tulane University. An instructive mimeographed booklet describing topographical and ecological features of the regions visited and a long list of the fauna and flora was given to each of the 50 people taking the trip. Undoubtedly some zoologists participated in the same trip on Thursday for the ecologists.

On Wednesday evening the zoologists' dinner was held at Kolb's restaurant, with 166 participating. The menu cards were written in Latin, and during dinner a colored quartet in native costume sang plantation melodies, greatly enjoyed by all. The after-dinner address was given by the retiring vice-president of Section F, Dr. Robert W. Hegner, on "How the Other Half Live." This will appear in SCIENCE. After the address a resolution was unanimously approved, expressing the thanks and appreciation of the society and of Section F to the members of the local committees, and others in New Orleans, who had made the whole program so successful. The usual biological smoker was held on Tuesday evening.

At the zoologists' business meeting Dr. W. C. Curtis was made president, with Dr. L. V. Heilbrunn vice-president, for 1932. Twenty-five active members and 20 associates were elected. An important action was taken by the society in voting appropriations of $500 to *Biological Abstracts* and $200 to the Union of American Biological Societies, sponsor for the *Abstracts.* A motion was also approved to secure by mail a vote from the entire membership on the proposition of raising the annual dues from two to five dollars, the additional amount to go to the *Abstracts*. A complete account of the proceedings of the society will appear in the January number of the *Anatomical Record*.

The Entomological Society of America held its twenty-sixth annual meeting on Tuesday and Wednesday, with 28 interesting papers covering nearly every field of entomology, and in addition, a symposium and the annual address. The annual invitational address by Mr. F. C. Bishopp, on "Waging War on Insect Enemies of Man and Animals," was given before a large interested audience. The symposium entitled "Blood-Sucking and Non-Blood-Sucking Flies in Relation to Human Welfare" was excellently presented by Mr. F. C. Bishopp, Mr. H. H. Schwardt, Mr. E. H. Hinman, Professor W. B. Herms and Professor Ernest Carroll Faust. The following comments were made by Dr. Faust in summing up the symposium: "While the scourge to human life from the transmission of disease by insects has been greatly reduced and ameliorated since the beginning of the century, blood-sucking insects are still one of the most important sources of human disease, particularly to non-immune populations. We still have with us at one place or another on this earth malignant malaria, yellow fever, dengue, the trypanosomiases, leishmania infections, the rickettsial diseases, the filariases, and other scourges to civilization, just as definitely as they existed two thousand years ago. In fine, insects are still one of the most important sources from which man contracts disease." The subjects on the general program included studies in insect physiology, morphology, bionomics, ecology, taxonomy, nomenclature, parasitology and some which had a direct relation to applied entomology. Dr. Emil Bogen, in a paper outside the field of entomology, strictly speaking, discussed the common and highly poisonous spider known as the "black widow," and cited many cases of fatalities from the bite of this spider. Six excellent exhibits were presented. The meetings were presided over by President J. W. Folsom. Officers elected for 1932 are: *President*, J. J. Davis; *first vice-president*, F. C. Bishopp; *second vice-president*, W. B. Herms; *secretary-treasurer*, H. B. Hungerford.

The annual meeting of the American Association of Economic Entomologists and its sections convened in the Municipal Auditorium in New Orleans. The space allotted was very satisfactory, and while the attendance was not quite as large as usual, nearly 200 members and visitors were present at the opening session. In the afternoon and on the following day three sections of the association met, and papers were read on special subjects, such as apiculture, plant quarantine and inspection, extension entomology and research work on toxicology and insect physiology.

The reports of the officers and the various committees indicated that the Entomological Association was making progress. Eighty-five new members were elected and four were reinstated. Only three members were lost during the year by death. The total membership at the close of the meeting was 1,241. Professor W. P. Flint, of Urbana, Illinois, was elected president, and Professor A. I. Bourne, of Amherst, Massachusetts, secretary.

The seventh annual meeting of the American Society of Parasitologists was held on Tuesday, Wednesday and Thursday, under Acting President A. C. Chandler, of the Rice Institute. The program was as notable for the number of its contributors as for the interest attaching to the content of many of the reports. Of 71 classifiable papers on the society program, 12 were in entomology, 37 in helminthology and 22 in protozoology, of which half were presented in person to audiences as large as at Cleveland. The society met jointly with the American Society of Zoologists on Tuesday morning, and with Section N in the afternoon for an invited symposium "On Parasitology of Medical Interest." The Tuesday afternoon session of invited papers was participated in by Drs. R. Hegner, W. E. Dove, C. W. Stiles, P. D. Lamson and G. F. Otto, with topics, respectively, on amoebiasis in Panama, the transmission of endemic typhus, control of hookworm disease in the United States under present conditions, the chemotherapy of the common intestinal helminths of man, and roundworm and whipworm infestations of man in the southern United States. On this program the discussions were initiated by several designated specialists. (See the report of Section N.) On Tuesday evening the society held its first annual dinner, at which over 50 persons dined on Creole food at its best, following which Dr. A. C. Chandler gave an address on "Susceptibility and Resistance in Helminthic Infestations." Dr. Chandler's address summarized the findings in this rapidly growing division of interest in parasitological research and gave added point to many of the angles of the problem of resistance to nematode infestations by illustrations from recent unpublished work in his own laboratory. Wednesday morning's session, largely zoological in character, was matched by a program on Thursday morning, largely medical in interest, with a demonstration period on Wednesday afternoon. Among the subjects considered were insects as intermediate hosts of various helminthic parasites, the life history of a blood-inhabiting protozoan of ducks with a biting fly as vector, coccidiosis of chickens and rats, ciliates of guinea pigs, a pathogenic nematode of pigeons, abnormalities of parasitic flat worms, variations in one of the amoebae of man as revealed in a long series of consecutive examinations from one parasitized host, the transmission of intestinal protozoa of man by flies and other potential vectors, a puzzling flagellate group of parasitic protozoa in man, recent studies of hexylresorcinol as an anthelmintic, the relation of diet to susceptibility in dogs to the canine hookworm, the effects in the rat of successive infections with a nematode, skin reactions of human subjects with trichina antigen, immunity studies with tapeworm material in rats, comparative studies of the eggs and life histories of certain Californian anopheline mosquitoes, the life history of an eye gnat of medical interest and lice in relation to their hosts. A program feature of much interest to the society also was the general address given on Monday evening in the Municipal Auditorium by its past president, Dr. R. P. Strong, on "The Family Filiariidae."

At the business meeting on Wednesday the following officers were elected for 1932: *President,* M. C. Hall; *vice-president,* W. H. Taliaferro; *secretary-treasurer,* Norman R. Stoll, Rockefeller Institute, Princeton, N. J.; *council members for four years,* J. F. Kessel and D. H. Wenrich.

The Wilson Ornithological Club met on Saturday, Sunday, Monday and Tuesday, with Saturday and Sunday given to an ornithological excursion to Avery Island as the guests of the Honorable E. A. McIlhenny, and Monday and Tuesday devoted to the reading of papers and the presentation of moving pictures. The papers and films covered a wide variety of topics, including reports of ornithological exploration, migration studies, local observations, the influence of ecological factors, such as temperature and relative humidity, Merriam's temperature laws, physiological tolerance of birds, egg-laying cycles, conservation, nesting, the mechanics of flight and methods of study. Seven titles were presented by moving pictures. Among the features of the meeting was the announcement of the finding of nesting golden eagles in the eastern United States. Mr. Ganier found a nest in the Cumberlands of Tennessee after a search involving leisure time for three years. The work of Kendeigh on the physiological tolerance of birds for cold is of very great significance, since winter nights may be too cold for certain species to survive through the night. This work on minimum temperatures paved the way for Shelford's criticism of Merriam's laws of temperature summation on the ground that the temperature summation curve does not agree with the actual experimental results at very low temperatures, such as occur frequently at night in the winter, or with very high temperatures, such as occur on almost any summer's day.

A very significant paper was given by Mr. Glenn W. Bell, indicating the great influence of the progress of the nesting cycle upon the *amount* of song of different species. Mr. Paul R. Elliott, in his paper, gave data showing the effect of temperature on the songs of birds. High temperatures are especially important for the mockingbird.

Perhaps the above papers represent the high lights of the Wilson Club program, but they give a very inadequate idea of the program as a whole.

A very pleasing dinner program was climaxed by the talk on the conservation policy of the National Association of Audubon Societies by its president, Mr. T. Gilbert Pearson.

SECTION G (BOTANICAL SCIENCES). **BOTANICAL SOCIETY OF AMERICA. **AMERICAN PHYTOPATHOLOGICAL SOCIETY. **AMERICAN SOCIETY OF PLANT PHYSIOLOGISTS

(*Reports from Sam F. Trelease, A. J. Eames, A. S. Foster, L. M. Leonian, J. M. Arthur, W. T. Penfound, W. E. Loomis and F. C. Meier*)

Section G met on Tuesday afternoon in joint session with the associated botanical societies. Dr. E. J. Kraus delivered his address as retiring vice-president for Section G, his subject being the organic nutrition of plants. This address was followed by a symposium on tropical botany. After introductory remarks by Dr. E. D. Merrill, chairman of Section G, a paper by Professor F. L. Stevens on tropical pathology and mycology was read. Professor S. J. Record outlined an international program for a world-wide study of woods. Dr. H. A. Gleason discussed the progress of botanical exploration in tropical South America. Professor H. H. Bartlett spoke on plans for conducting a biological survey of the Maya area of Central America.

The Botanical Society of America held a most successful meeting from Monday to Thursday, with a membership attendance of about 200. Five sections held well-attended meetings for the readings of papers on three days. The three morning sessions of the general section were well attended and papers dealing with a wide range of botanical papers were presented and discussed. On Tuesday morning, the papers dealt largely with problems of ontogeny and morphogenesis, including reports of foliar development in several woody dicotyledons and in *Nicotiana,* regeneration in *Bryophyllum,* development of peltate hairs in Shepherdia and factors determining the size of the vascular system in fern petioles. During the Wednesday morning session, the papers dealt with various phases of morphology and anatomy, including the embryogeny of *Cryptomeria* and *Chamaecyparis,* the comparative morphology and ontogeny of certain hepatics, the formation of multiple male cells in *Cupressus arizonica,* the anatomy of certain cacti, the method of growing and commercial preparation of important Philippine fiber plants, the factors influencing the formation of tyloses in *Juglans* and the origin of adventitious roots in cuttings of *Rosa* and *Cotoneaster*. One paper of particular morphogenetic interest showed the essential similarity of the wound responses of gymnosperm and dicotyledonous foliage leaves. On Thursday morning a number of papers of cytological interest were presented, including an account of diploid and tetraploid forms in *Tradescantia* and certain unusual nuclear phenomena in ferns. In addition, a description was given of structural features of a new species of *Calamites* and of a *Lepidocarpon*, and a paper treating of divergence in evolution, as shown by extermination experiments on certain "high" and "low" algae, was read. During the last session, Dr. M. A. Chrysler, of Rutgers University, was elected chairman of the general section for the coming year.

The annual dinner for botanists was held on Wednesday evening, with an attendance of 184. President C. J. Chamberlain presided, and Retiring President L. W. Sharp delivered the presidential address. Through the courtesy of the New Orleans Botanical Society and New Orleans University, entertainment was provided by a colored quartet. Announcement was made of the election of the following officers for 1932: *President*, G. J. Peirce; *vice-president*, A. J. Eames; *secretary*, S. F. Trelease; *editors, American Journal of Botany*, L. W. Sharp, B. M. Duggar; *representative, National Research Council*, A. J. Eames; *alternate to representative*, Margaret C. Ferguson.

One day was given in some sections to an all-day field trip, an unusual feature of winter meetings, which was very popular and successful.

The mycological section held one sectional meeting and a joint session with the Phytopathological Society. Papers were presented covering a wide field of topics, such as parasitic habit of *Marasmius sacchari*, distribution of fungi over the world, utilization of cellulose by myxomycetes, cytological studies of *Tulasnella*, phylogeny of fungi, morphology of *Entomophthora*, sexual condition in *Dictyuchus*. During the business session it was proposed that a mycological society be formed, with *Mycologia* as its official organ. A questionnaire, previously sent to members of the section, revealed the fact that the majority of members favored the formation of such a society. The American Mycological Society was formed, and the following men were elected officers: *President*, W. H. Weston; *secretary-treasurer*, H. M. Fitzpatrick; *councilors*, N. E. Stevens, C. R. Orton and H. S. Jackson.

Sessions of the physiological section were held on Tuesday, Wednesday and Thursday mornings. Four papers on seed germination were presented: Alice M. Andersen discussed the effect of dilute nitric acid and alternating temperatures in forcing germination of bluegrass seeds; Johanna Giersbach, William Crocker and Lela V. Barton gave papers on the effect of both dry and wet storage followed by low after ripening temperatures on the germination of wild plum, silver bell and bayberry seeds. Dr. B. E. Livingston and Mr. W. B. Mack told of the effect of oxygen pressure and ethylene on the CO_2 output of wheat seedlings. Dr. W. T. Swingle stated that the Satsuma orange in Japan produced bud spores which remained dwarfed, but that the same species had been growing along the Gulf Coast of the United States for 50 years and had produced no dwarf mutations. The production of this mutation in Japan was attributed to the low temperatures of spring and summer. Dr. Swingle also discussed the commercial possibility of using pollen from late or early maturing varieties of dates as a means of hastening or retarding fruit production in various species of the date palm. Professor W. H. Chandler presented evidence to show that pollen cells are killed by the formation of ice crystals during freezing. It was found by Professor Evelyn I. Fernald that the region of greatest freezing point depression in asparagus tips was about 1.5 to 3.7 cm below the tip. Professor H. S. Reed discussed the effects of mottle-leaf disease of citrus on the cells of the leaf; the progress of the disease reduces the number of palisade cells and greatly increases the acidity of the protoplasm. Mr. A. S. Crafts observed that sieve tubes become permeable when mature and that they provide conduits for the movement of organic foods going from the leaves. Five papers on radiation were given: Mr. H. J. Fuller and Mr. F. L. Wynd reported that enzymes were increased in plants exposed to the lethal ultra-violet region; plants similarly irradiated by the use of regions of longer wave-length showed an increase in calcium and a decrease in phosphorus; Professor B. M. Duggar and Mr. A. Hollaender, using monochromatic radiation of definitely defined intensities, reported that far greater intensity is required to inactivate the virus of tobacco mosaic than to kill bacteria; Mr. J. M. Arthur and Mr. W. D. Stewart presented papers on the production of red pigment in apples upon exposure to various artificial light sources, and the increase in growth and dry weight brought about by shading plants down to 35 per cent. of open sunlight during June and July. Dr. E. F. Davis described the effects of placing seeds and other living cells in centrifugal forces of a million times gravity in a super centrifuge, observing that cells often recovered from forces which were sufficient to throw the protoplasm against one side of the cell. Dr. Davis discussed other studies made on the reduction of the toxic substance juglone, produced by the black walnut. By the injection of oxidation-reduction indicators *Trianea bogotensis* was found to have the power of reducing juglone. The abstracts of most of the papers presented will be found in the supplement to Vol. 18, *American Journal of Botany*, December, 1931. The officers of the section for the new year are: *Chairman,* F. E. Denny; *vice-chairman,* E. C. Miller; *members of the board,* G. J. Peirce and O. F. Curtis; *secretary-treasurer,* J. M. Arthur.

The systematic section, under the chairmanship of Dr. B. C. Tharp, held two meetings of the section, two joint meetings and one all-day field trip. At the Tuesday morning session Dr. Frank Gates gave an interesting discussion on the rapid spread of new plants into and throughout Kansas along roads and railroads. The Russian thistle, so numerous and troublesome in the past, has almost ceased to be a pest. Dr. Ottley indicated that the species *Petunia axillaris* and *P. violacea* can readily be separated on the basis of pollen grains and that the forms passing in horticultural and genetical literature as these species are mainly hybrids. Dr. Minna Koch indicated that the position of the tribes of the Compositae as at present found in the manuals does not correlate with her findings.

The symposium on southern vegetation on Wednesday was attended by approximately 100 persons. The habitat of the Venus fly-trap, the vegetation of the fresh-water lakes and that of the haystack dunes were interestingly described and pictured by Professor Ives. Professor Kurz stated that some eighteen species of northern plants, not otherwise found in Florida, may be found along the Apalachicola River bluffs, in the Tallahassee red hills and in the Marianna red lands. Dr. Miriam Bomhard described and pictured some fourteen species of palms introduced into New Orleans and the difficulties of identification set forth. In the business session which followed officers for 1932 were elected as follows: *Chairman,* Alfred Gunderson; *secretary,* Norman M. Grier.

The American Society of Plant Physiologists held a very successful and well-attended meeting. Forty research papers were presented at the regular sessions of the society. One period was devoted to a round table discussion of research methods, with Dr. W. E. Tottingham as the leader. Drs. C. O. Appleman, E. S. Johnson, Walter Thomas and others discussed different phases of the topic. Two joint sessions were held, one with the American Society for Horticultural Science, and the other with Section G, the Botanical Society and the American Phytopathological Society.

At the annual dinner of the society the retiring president, Dr. Tottingham, presented an address on "The Contribution of Plant Physiology to Biochemistry." Dr. C. O. Appleman was elected Charles Reid Barnes life member of the society. In his acceptance Dr. Appleman stated that he was waiting in Dr. Barnes' classroom at the time Dr. Barnes was accidentally killed on his way to class.

At the scientific sessions of the society Dr. J. H. Beaumont reported that the photoperiodic response of Irish potato could be reversed by changes in growing temperature of less than 10° C.; Dr. J. C. Ireland described an instrument for recording sunlight intensities; Dr. E. J. Lund and his students presented new evidence on the nature of electrical polarity in plants. Dr. E. S. Johnson reported that the phototropic response in plants is conditioned by green and blue light and not by the red; Dr. G. W. Scarth found that stomatal movement of many plants is affected by temperature as well as by light, water and CO_2. Dr. W. H. Eyster reported that certain strains of maize were apparently unable to utilize sugars unless supplied artificially with insulin; Dr. J. P. Bennett found that the iron in the chlorotic leaves of plants on calcareous soils is held in the leaves in an insoluble form, and Dr. E. S. Reynolds reported that while tree trunk temperatures follow air temperatures they lag significantly during falling temperatures.

The American Phytopathological Society held its twenty-third annual meeting from Tuesday through Thursday, in conjunction with its southern division, with about 125 pathologists in attendance. Forty-eight new members were added to the rolls, bringing the total membership to slightly over 836. The following officers were elected: *President,* F. D. Heald; *vice-president,* J. G. Dickson; *secretary-treasurer,* F. C. Meier (reelected); *councilor,* L. O. Kunkel. Dr. L. E. Miles was elected councilor, representing the southern division. H. B. Humphrey was reappointed editor-in-chief of *Phytopathology.* Ninety-six papers were delivered before the society's several sessions. Three joint sessions were held, as follows: with Section G of the American Association, Potato Association of America, and Mycology Section of the Botanical Society of America.

Full abstracts of the papers presented will appear in the January, 1932, number of *Phytopathology.* The important advances made in the sessions are mentioned below. The use of naphthalene against soil organisms of the *Sclerotium rolfsii* type was declared by Dr. Freeman Weiss and Mr. E. L. Evinger to be very effective and inexpensive. Transmission of the peach phony-disease virus, according to Dr. Lee M. Hutchins, is possible only through diseased roots, the virus apparently having the ability to travel only in an upward direction and becoming inactive when diseased tops are grafted onto healthy roots. Controlling bottom rot of lettuce by dusting with mercurial dusts, as developed by Dr. G. R. Townsend, is the only method of combatting this serious New York disease, efforts along all other lines having been in vain. The greenhouse dissemination of cereal-rust spores led to the discovery of a fungus and bacterium, both apparently part of the normal intestinal flora of the garden slug, and yet pathogenic to the cereal rust-fungi, declared Professor A. A. Granovsky, Dr. M. N. Levine and Dr. J. G. Leach in two papers. The question whether *Bacterium tumefaciens* is a mutant or a pathogenic pleomorph of *Bacillus radiobacter* was raised by Miss Nellie A. Brown and Mr. Lewis T. Leonard. Mr. Sydney Dickinson and Mr. M. B. Moore, in separate papers, comprehensively discussed the genetics of the smut fungi, *Ustilago zeae*. The natural hybridization of cereal rust biologic forms was reported by Dr. E. C. Stakman, Mr. Lee Hines, Dr. Ralph U. Cotter and Dr. M. N. Levine. The following new diseases were reported: a bacterial disease, related to fire blight, by Dr. H. R. Rosen; *Clitocybe* mushroom rot of bananas and citrus, by Mr. Arthur B. Rhodes; a seedling-blight stage of onion bulb rot, by Mr. Glenn N. Davis and Dr. Chas. S. Reddy; *Ophiobolus oryzinus* on rice in Arkansas, by Dr. E. C. Tullis; *Ampelomyces quisqualis* on *Erysiphe polygoni*, by Mr. Cecil E. Yarwood; *Erysiphe malachral* on cotton, by Dr. E. V. Abbott; stunt of Cyclamen, by Dr. L. M. Massey and Mr. Paul E. Tilford; and "June yellows" of strawberries, by Mr. A. G. Plakidas.

SECTIONS F AND G (BOTANICAL AND ZOOLOGICAL SCIENCES). ** AMERICAN SOCIETY OF NATURALISTS. ** ECOLOGICAL SOCIETY OF AMERICA. ** AMERICAN MICROSCOPICAL SOCIETY. GENETICS SECTIONS, AMERICAN SOCIETY OF ZOOLOGISTS AND BOTANICAL SOCIETY OF AMERICA. † PHI SIGMA BIOLOGICAL RESEARCH SOCIETY

(*Reports from J. H. Bodine, Alfred Emerson and James E. Ackert*)

The annual symposium of the American Society of Naturalists was held on Thursday afternoon. The general subject for the session was "The Biology of Sex." Dr. C. E. Allen discussed sexual differences in angiosperms and bryophytes, stressing sex potency and sex-influencing factors, as well as sex tendencies in these groups, and pointed out ways in which sex may be modified in plants. Dr. Emil Witschi discussed the theories relating to causes of sex in animals, reviewing the present knowledge and pointing out especially sex conditions and the results of experiments with amphibia. His theory proposed a so-called "inductor" or "hormone" theory of sex-differentiation. In the final paper, Dr. H. J. Muller discussed the evolution and biological significance of sex and its relation to the diffusion of mutations through a population. He emphasized the increasing importance of particular genes through a "focal process," marking a critical point in sex-differentiation.

At the business meeting, immediately following the symposium, the society formally adopted the recommendations of the committee on policy which were tentatively accepted at the Cleveland meeting a year ago. Officers elected for 1932 are R. A. Gortner, *president*, and H. J. Muller, *vice-president*. E. W. Lindstrom was elected secretary for a term of three years and Sewall Wright was reelected as treasurer for two years. It was voted to appropriate $50 from the treasury to the Union of American Biological Societies and $50 directly to the support of *Biological Abstracts*. Fifty-two new members were elected.

The naturalists' dinner, which was well attended, was held on Thursday evening. The presidential address which will be printed in SCIENCE was given by Dr. S. J. Holmes, who pointed out that the contacts of whites with more backward races was likely at first to be greatly to the detriment of the latter, but that later a symbiotic relationship developed which was of mutual advantage. He emphasized, however, that this was likely to be succeeded by a stage in which the biological advantages were reversed, resulting in a numerical increase of the less advanced race.

The Ecological Society of America under the presidency of Dr. A. O. Weese held sessions on Monday, Tuesday and Wednesday, with an attendance varying from 25 on Tuesday morning to 65 at the joint session with the Botanical Society of America on Wednesday afternoon. The notable features of the meetings were the joint sessions with the American Society of Zoologists and the Botanical Society of America and the two symposia. The first symposium in charge of Dr. Walter P. Taylor concerned "Ecological Aspects of Wild Life Management," and the second, in charge of Herbert C. Hanson, concerned "Methods in Range Ecology." The committees on the study of plant and animal communities and the preservation of natural conditions under the chairmanship of Dr. V. E. Shelford, had numerous well-attended conferences during the week. A delightful semi-popular lecture entitled "Cypress Scenes and Unseens" was given by Dr. Herman Kurz. The ecologists' dinner was held informally at a French restaurant, at the close of which the vice-president, Dr. Francis Ramaley, gave a short illustrated address on "The Great Sand Dunes of Colorado," and Mr. Percy Viosca discussed the ecological aspects of the local flora and fauna. The field trips on Thursday and Friday in cooperation with the Botanical Society of America and the American Society of Zoologists were favored by perfect weather and were attended by 183 persons. Drs. E. S. Hathaway and W. I. Penfound and Mr. Percy Viosca led the parties by bus through delta forests, fresh and salt water marshes, cypress and sour gum swamps and pine forests. Many took advantage of the excellent opportunity for collecting and observing plants and animals in the varied ecological habitats

At the business meeting on Tuesday afternoon, the following officers were elected: Dr. George E. Nichols, *president;* Dr. Joseph Grinnell, *vice-president;* Dr. Raymond Kienholz, *secretary-treasurer;* Dr. Alfred E. Emerson, *editor of Ecology;* Dr. George D. Fuller, *associate editor* and Doctors A. O. Weese, A. G. Vestal, C. T. Borhies and Stanley Cain, *board of editors of Ecology.*

The American Microscopical Society held its fiftieth annual meeting on Wednesday. The following officers were elected for 1932: *President,* Dr. E. M. Gilbert; *first vice-president,* Dr. Robert T. Hance; *second vice-president,* Dr. I. M. Lewis; *treasurer* (three years), Dr. A. M. Chickering, Albion College, Michigan; elective member of executive committee (three years), Dr. J. E. Guberlet. The custodian, Dr. Henry B. Ward, reported that the Spencer-Tolles Fund is now in excess of $16,000. Drs. J. E. Ackert, secretary, and E. M. Gilbert were named to represent the society in the council of the American Association.

Routine business matters were attended to by the National Council of Phi Sigma, and preliminary plans were made for the holding of a scientific session at Atlantic City next year for the reading of papers by student members.

SECTION H (ANTHROPOLOGY)

(Reports by Carl E. Guthe and C. H. Danforth)

In the realm of physical anthropology emphasis centered very largely around the question of growth. Papers and discussions in this field at New Orleans at the joint sessions with Section K (Statistics, Economics and Sociology) and Section N (Medical Sciences) were focused to an unprecedented degree on the individual, as contrasted with the group. Indeed, the sessions devoted to this subject left a rather definite impression that we may be at the beginning of a new era, in which individual, rather than mass studies, will be foremost. The importance of observing the same individual over the largest possible period was emphasized by nearly every speaker who dealt with any aspect of development. Among these, President Boas emphasized, in his address, the extent to which many statistical procedures tend to smooth out differences that actually exist and are significant; Dr. R. E. Scammon introduced novel data on the reliability of measurements and brought out effectively the importance of seriation and consecutive measurements on the same subject; Dr. H. Bakwin showed the importance of physical types in relation to diseases of infancy, as revealed by studies of individual infants over considerable periods; Dr. O. Klineberg stressed the necessity of considering rate of growth and growth span in studies of physiological age or "intelligence quotients," and emphasized especially the fallacies inherent in conclusions from data on groups based on chronology.

Advances in the study of skin color and hair were reported, respectively, by Miss Charlott Morrel and Miss Mildred Trotter. It appears that in untanned skin of present-day students, the black component is higher in males than in females (as conventionally depicted in some prehistoric paintings). The persistent belief that curl of the hair is directly related to flatness of the shaft was again shown to be fallacious, this time in the Arab. Arab hair is of especial interest, in that the most flattened shafts are the largest.

A study of body build and racial extraction of girls of Newcomb College showed, according to Dr. H. N. Gould, an increasing slenderness up to 1927, followed by a tendency toward a heavier build. Although the percentage of students of "Old American" stock is exceptionally high, there has been a great deal of racial displacement, and the present number of students of French and Spanish descent is remarkably low in New Orleans.

In the field of cultural anthropology two specific groups of research were emphasized, largely because of the geographical location of the annual meetings. It was possible to take advantage of the presence of a number of men from Southern institutions, who presented papers upon investigations in their areas. The existence of the Department of Middle American Research at Tulane University and the presence of a few members of field parties about to undertake work in Central America proved an excellent opportunity to discuss problems concerning Middle American anthropology.

At the opening session on Tuesday morning, Mr. Barnum Brown, of the American Museum of Natural History, gave a brief review of the developments during the past year, concerning the antiquity of man in North America. He referred to the finding of an arrow-point under the shoulder-blade of an extinct elephant in Nebraska and to the finding of two artifacts and a hearth of considerable antiquity near Tucson, Arizona. The major portion of his paper was devoted to a discussion of an important discovery of a cave in southeastern New Mexico by a party from the University of Pennsylvania. Here, evidence of human life was found in association with a large series of animal remains, many of which represented extinct mammals, such as the camel, muskox, horse, etc. Dr. Herskovits, of Northwestern University, presented interesting sociological data concerning the rôle played by the "Best Friend" in Dahomey in Africa. Dr. Gilmore gave a brief report upon the accomplishments of a recently organized Ethnobotanical Laboratory at the University of Michigan, which is prepared to identify botanically such anthropological materials as come to its notice.

Part of the sessions were devoted to papers concerning the archeology of the Southern states. Professor Pearce, of the University of Texas, with the aid of lantern slides, reviewed the material culture of the peoples who had once lived in eastern Texas. The excellent work which they did in pottery and shell, as well as in other materials, indicates a cultural relationship with the southern Mississippi Valley civilizations. Dr. Dellinger, of the University of Arkansas, had two papers upon the program, one of which concerned the interesting textiles and perishable material obtained by him in one of the caves of the Ozarks, and the other, the records of former Indian life, as illustrated in the pottery and pictographs from northern Arkansas. Dr. Renaud, of Denver University, discussed a group of unusual pictographs which he had found in central Wyoming, of definite cultural significance.

Several sessions of Section H, held jointly with Sections K and L, were devoted to a discussion of Middle American anthropological problems. (See the report of Section L.)

At the annual dinner of Section H, Dr. Carl E. Guthe, of the University of Michigan, the retiring vice-president, gave an address upon the Maya lunar count, in which he presented some interesting results of a mathematical consideration of the Maya method of counting lunations.

The following evening, the members of the section were privileged to see six reels of motion pictures taken on several expeditions sent out by the Department of Middle American Research of Tulane University to southern Mexico and northern Central America. Mr. Frans Blom interpreted this interesting and, in certain instances, unique record.

Those who attended the meetings of Section H have felt that the few days spent in New Orleans were very successful from a scientific standpoint and personally enjoyable. This was due to the wholehearted and courteous hospitality extended to the members of this section by the Department of Middle American Research of Tulane University. Mr. Frans Blom, the director, and all the members of the staff, as well as many of the friends of the department, did everything in their power to make the visit to New Orleans a delightful one.

SECTION I (PSYCHOLOGY). †SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

(*Report by John E. Anderson*)

Section I held sessions from Tuesday, December 29, to Thursday, December 31. The vice-presidential address, entitled "The Physiology of Consciousness," was given by Dr. Edwin G. Boring, of Harvard University, retiring vice-president for Section I, at a joint dinner with Section Q held on Tuesday evening. Dr. Boring, after a critical analysis of recent points of view and the implications of modern researches in psychology, neurology, physiology and related fields for the problem of consciousness developed the thesis that introspection is a method for the observation of certain events in the brain. At this dinner Dr. Leonard A. Koos, of the University of Chicago, retiring vice-president of Section Q, described the methods and procedures used in the national survey of secondary education now under way. On Thursday afternoon a joint session with Sections C and N was held. This took the form of a symposium on mental disorders. Dr. Abraham Myerson, of Tufts Medical College, speaking on the "Biochemical Aspects of Brain Activity," presented the results of chemical analysis of arterial blood flowing into the brain and the venous blood returning from the brain to show that in a brain activity much sugar is utilized. Dr. F. A. Moss, of George Washington University, speaking on "The Scientific *vs.* the Psychic Approach to the Study of Mental Disorders," pointed out the necessity of continuing our investigations on the physical causes of mental disorders and showed that the practical results claimed for the psychic approach should not deter us from more fundamental studies. Dr. G. Holmes Richter, of the Rice Institute, speaking on "The Colloidal Chemistry of Psychiatry," presented the results of observations with the bright field microscope on the activities of living nerves and stressed the importance of recent researches in colloidal chemistry for our understanding of the nervous system and psychic phenomena. (See the report of Section N.)

On Tuesday, Wednesday and Thursday mornings the Southern Society for Philosophy and Psychology held its twenty-seventh annual meeting. Contributed papers, both from members of the Southern Society and from members of Section I from other districts of the country, were presented. A total of 35 papers, covering a wide variety of topics in the field of psychology and philosophy, were read. The Tuesday morning sessions contained a number of papers on the acquisition of motor skills and on memory and forgetting. The Tuesday afternoon session was concerned largely with sensory and perceptual phenomena. The Wednesday morning sessions were devoted to papers on philosophy; the Wednesday afternoon sessions to papers on child development and on intelligence tests, and the Thursday morning sessions to abnormal mental phenomena and to studies of emotion. All the sessions were well attended and were marked by energetic and interesting discussion.

At the dinner meeting of the Southern Society held on Wednesday evening, Dr. Harry M. Johnson, of the American University, gave the presidential address, entitled "Some Follies of Emancipated Psychology." He made a searching analysis of psychological material appearing in text-books and in popular presentations of psychology in order to demonstrate the errors that arise in the transition from scientific reports to text-book and popular presentation. At the business meeting of the society, Miss A. F. Liddell, of the Florida State College for Women, was elected president of the Southern Society.

SECTION K (SOCIAL AND ECONOMIC SCIENCES)

(*Reports from Harold Hotelling, Irving Fisher and Howard Richards*)

At the Monday session of Section K, Professor Sanford Winston described a sample of more than five thousand completed families selected with reference to social class. More boys in proportion to girls are born to parents in prosperous circumstances than to the poor, according to Professor Winston. He found further that small families had a higher proportion of males than large families, which is another indication of the greater excess of males in the higher economic groups, since these groups have fewer children. This effect he attributed to the better prenatal care which mothers in the more prosperous families receive, with the result that fewer miscarriages occur. Since a great preponderance of miscarriages are male, a large number of interruptions of pregnancy, resulting from neglect, poverty and ignorance, leaves fewer males to be born alive.

The sturdy conservatism of the rural people of Vermont in holding tenaciously to their soil through one economic reverse after another was pictured by Professor Genieve Lamson, of Vassar College, as she traced their shifts and changes in response to difficulties brought on by the repeated lowering of the prices of their products. She described the pride of these old-time American families in having given so many leaders to the nation, the consolidation of farms now taking place, with vacant buildings as one result, and the slightness of the infiltration of foreigners, who are chiefly French Canadians.

Professor R. M. Harper showed graphically at this session the interrelations of demographic factors in the population of Switzerland. President A. O. Bowden, of New Mexico State Teachers College, described the results of a questionnaire showing an appallingly great amount of superstition and ignorance in the general population, with only a slightly better showing by school teachers. These papers were presented on Monday afternoon, the section abstaining from a Monday morning session in order to allow the members to attend the meeting of the American Mathematical Society devoted to statistics.

A symposium on cotton was held on Tuesday morning in the municipal auditorium, under the chairmanship of Mr. L. L. Janes, of the United States Department of Agriculture. Mr. S. Locke Breaux, who has been connected with the New Orleans Cotton Exchange since 1875, opened the symposium with an account of the activities of the exchange, defending it against the attacks which have been made in Congress and elsewhere. The invitation to visit the exchange, extended to all members of the association, was seconded by Mr. Breaux and taken advantage of by a number of members of Section K. Owing to the unavoidable absence of Mr. J. W. Bateman, director of agricultural extension at Louisiana State University, his paper on "Cotton from the Viewpoint of the Farmer" was read by Dean J. G. Lee. Mr. Robin Hood, secretary of the National Cooperative Council, spoke on "The Objectives of the Cotton Cooperatives."

The social and economic institutions of the Mayans were the subject of a symposium on Tuesday afternoon jointly with Section L. (See the report of Section L.)

Professor Charles A. Ellwood, of Duke University, presided at the Wednesday morning session and opened the meeting by stressing the importance of historical as compared with psychological methods. Professor Kenneth E. Barnhart, of Birmingham-Southern College, showed that the high homicide rates in Southern cities represent chiefly murders among illiterate Negroes. He predicted that the rapid growth of literacy now taking place, particularly in the colored population, will result in a decrease in the number of homicides. Professor Walter C. Reckless, of Vanderbilt University, spoke on the use of observation and statistics in the placement of foster children, describing observations made on orphan children for five-minute intervals with a view to an objective evaluation of traits relevant to their placement. Professor M. D. Anderson, of the University of Florida, described his interesting "relativity theory" of capital and interest illustrating the theory with graphs of the trends of financial variables.

A symposium on growth was held, jointly with Sections H and N, in two parts, on Wednesday afternoon and Thursday morning. (See the reports of Sections H and N.)

The subject of growth was resumed in a different application by Professor Edwin B. Wilson, of the Harvard School of Public Health, who spoke on Thursday afternoon at a joint session with Section A (Mathematics) on "Laws of Population Growth." With Miss Ruth R. Puffer, Professor Wilson used the method of least squares to fit logistic curves to a considerable number of human populations. The fit was in general close; but the characters of the parameters of the curve determined in this way were often surprising. In some cases the parameters were imaginary or of a sign opposite to that usually attributed to them. The curve, which is ordinarily assumed to rise more slowly than the Malthusian geometric progression, sometimes rose even more rapidly than that suggested by Malthus, actually approaching a vertical asymptote. The absurdity of these results formed the basis for the authors' opinion that the logistic curve is of very little value for predicting populations.

Earlier on Thursday afternoon a joint session with Section L was addressed by Professor Robert G. Caldwell, of Rice Institute, and by Professor William B. Munro. (See the report of Section L.)

The Econometric Society met jointly with Section K in New Orleans, Louisiana, on the morning and afternoon of January 1, 1932. Three papers were presented at the morning session, at which Professor Griffith C. Evans, of Rice Institute, presided. The first, by Dr. Charles F. Roos, pointed out several errors in the static theory of cost and gave a dynamical theory which avoided these. Dr. W. A. Shewhart, of the Bell Telephone Company, pointed out the advantages of standardization and demanded a fairer basis for competition. The following paper was that of Professor Hotelling, which discussed certain surprising results of two interrelated demands when one of them was subjected to a tax. At noon a luncheon meeting was held, at which Professor Fisher, president of the Econometric Society, described its origin and objects.

Professor Hotelling presided at the afternoon session, four papers being presented. The program began with a paper by Professor Edwin B. Wilson (and Miss Margaret M. Hilferty), of Harvard University, which was a brief statement of the distribution of chi-square in comparison with the normal probability curve. The scond paper was that of Professor Evans, which treated the various uses and results of employing economic hypotheses. Dr. Mayer then suggested that classical dogmas regarding value be abandoned and that in social study we utilize the socio-psychological disciplines. The final paper was that of Professor Canning, who discussed whether there is such a thing as a "constant expense" in enterprise operations and attributed part of the amplitude of business cycle swings to belief in misleading income data.

The fifteenth annual meeting of the Metric Association was held on Tuesday. Dr. A. E. Fossier, director of the Board of Health of New Orleans, welcomed those attending on behalf of the City of New Orleans, and later in the day conducted a party to places of interest in and about the city. A paper by Dr. George F. Kunz pointed out various instances of the spread of metric measures in the United States. Mr. A. E. Pradillo, of the New Orleans Association of Commerce, suggested an educational campaign for the people to get acquainted with the advantages that would accrue to this country with the use of the metric system. A report was presented from Dr. Arthur E. Kennelly regarding the progress of the metric movement in Japan. Miss Leora Blair, of the Louisiana State Normal College, discussed her methods of teaching the metric system, using only the metric weights and measures needed for practical use.

Officers elected for 1932 are: *President,* George F. Kunz; *first vice-president,* Arthur E. Kennelly; *second vice-president,* Theodore H. Miller; *third vice-president,* Wm. Jay Schieffelin; *treasurer,* James F. Martin; *secretary,* Howard Richards.

SECTION L (HISTORICAL AND PHILOLOGICAL SCIENCES)

(Report from Richard Stephenson and Joseph Mayer)

Section L held its first meeting in joint session with Sections H and K on Tuesday afternoon, December 29, for a discussion of the culture and civilization of the ancient Mayas. Dr. S. G. Morley presented facts concerning the organization of various expeditions to the Maya field and the assistance obtained from various scientists in this field. Mr. Frans Blom discussed generally the articles of commerce, where these were obtained by the Maya, and their monetary system. He also displayed a large map which delineated in colors the areas from which the ancient Maya folk obtained their various commodities. This session was well attended.

The second session of Section L was held jointly with Section K on Thursday afternoon with Dr. Griffith C. Evans presiding. Professor Caldwell traced the repetition of periods of prosperity and panic through Colonial times, the land panic of 1819, the canal panic of 1837, the railroad panic of 1857 and the financial panic of 1873. He suggested that the rhythm may perhaps be due to each generation of men learning by its own mistakes, which are forgotten by the next generation. He spoke also of a theory of binary panics: an agricultural one shortly after a great war and an industrial panic about eight years later than this. The theory, he pointed out, is plausible, but on account of the inadequacies of the historical method can not be regarded as proved. He declared that the United States has brought the present depression upon itself by following at the same time the mutually incompatible policies of collecting its foreign debts and of maintaining a tariff that makes payment impossible.

Professor Munro ascribed the world depression to democratically inspired excessive governmental expenditures which exceeded the tax-collecting powers of the government and led to impairment of credit.

The third session of Section L was held jointly with Section H and was concerned with Maya archeology. By means of lantern slides Dr. S. G. Morley displayed photographs taken by Colonel and Mrs. Lindbergh in their flight over the Yaxchilan region, pointing out that the chief value of the Lindbergh photographs lay in the fact that for the first time the subject of Mayan archeology was given such publicity as to make it of national interest, and in the fact that the photographs from the air gave the excavators better ideas of the topography than could be obtained by land exploration. Dr. Morley next presented lantern slides concerning his own expedition of April, 1931, and discussed the significant discoveries made at that time. Dr. Hermann Beyer, of the Tulane Department of Middle American Research, read a most scholarly paper on "The Stylistic History of the Maya Hieroglyphs" from the earliest times through their decline after the Spanish conquest. And finally at the last session of Sections L and H, Mr. Frans Blom, of Tulane University, read a paper on "The Negative Batter at Uxmal and Other Maya Ruins," which presented the general fact that the façades at Uxmal lean outward to enhance the sculpturing on these façades.

SECTION M (ENGINEERING)

(Report from N. H. Heck)

The address of the retiring chairman of the section, Dr. Frank B. Jewett, dealt with the new place that must be taken by the engineer if society as a whole is to live a happy life and avoid some of the present dangers. We can not continue to live in a highly mechanized age on the rules and regulations suited to an earlier trading and agricultural age. The engineer must learn to take his place, first through better education of engineers to make them more competent to take a proper place in the whole scheme of society; second, his societies and allied organizations must see their responsibilities in a broader way, and, finally the rank and file of mankind must be educated so that they will not be fooled in regard to matters of science and engineering. Experience shows that we can not be so fooled without nature taking her revenge. Such education is easy for small groups but, in the case of millions, it is a grave task. In certain fields we are reaching the limits of possible developments and in such cases we should be content with a filling-in process. Engineers will have to have better understanding of the properties of materials and of the work being done by scientists in these fields. Future construction will have more refinement of detail than in the past. In accomplishing these things the engineer must not get too far from the field of creation or he will lose much of the mental satisfaction which most engineers are incapable of getting from the purely intellectual side of the work.

Lieutenant H. D. Vogel discussed the laboratory solution of river problems. He pointed out the difficulties encountered by experimenters in designing, building and operating small scale models of rivers, the need for better approach to this problem for rivers of large size and the absolute need, in the case of long stretches of river, for the use of distorted models, that is, with vertical scale considerably in excess of the horizontal. He showed that with suitable assumptions distorted models give good agreement with the results of observation of actual river performance. Accordingly, laboratory studies are indispensable in understanding river problems.

Mr. George G. Earl gave a complete analysis of rainfall at New Orleans, and, among other things, showed that three inches or more in one hour occurred eight times in thirty-six years and that there have been fourteen inches in nine hours over the whole forty-four square mile extent of the city. Since the whole city lies at, near or below gulf level, all rainfall, except that absorbed, must be removed by pumping through an elaborate system of canals which discharge into Lakes Borgne and Pontchartrain. The present capacity is fourteen inches in twenty-four hours for the entire area, a considerably greater discharging capacity than that of Chicago with ten times the drainage area. The prompt removal of rain water, combined with improved water supply and sewage disposal, have resulted in great improvement in sanitary conditions and consequently in living conditions.

Mr. C. F. Hirshfeld stated that for cities upward of 100,000, the continuation of the street railway is a necessity to provide transportation for the common man. At present 60 per cent. of downtown transportation is by street car, and only 8 per cent. of the original street railway mileage has been replaced by buses. The street railways from early prosperous conditions are now in a generally bad way, and development of new ideas is necessary to render the street car sufficiently attractive to compete with other forms of transportation. Through cooperation of the companies an organization has been formed to learn the facts and find remedies. A questionnaire brought out the demand for better ventilation and quietness rather than for mechanical perfection and speed. The significance of the investigation is that means must be found to save an industry of five and one half billion, with the certainty that, if lost, there must be replacement at even greater cost.

Mr. J. F. Coleman dealt with foundation problems in New Orleans. The existence of alluvial deposits of great depth, complicated by local deposits of quicksand a few feet below the surface, and in other places with beds of fine clay and of decayed vegetation, presents a foundation problem of unusual difficulty. Until recently most of the material was saturated at a depth of a few feet, but in some places drainage has lowered the upper limit of saturation. Before drainage the upper surface gave better bearing for loads than the subsurface. The drainage has in some cases resulted in the decay of wooden substructures with consequent settling of buildings. In other cases the surface has settled through several feet, even without load. In some cases this settling has exposed cypress stumps, belonging to one of several layers of buried swamps, and a structure resting on a stump is at an obvious disadvantage. Great care is necessary in the design of foundations and piles must be driven with great care. Often they must be so thickly placed that those last driven force the others up, with later settling and carrying the structure with them.

Major R. F. Fowler, U. S. Engineers, discussed inland waterways. In spite of the great development of the railroads certain types of freight, including such low grade bulk cargo as coal and steel products, have continued to be carried by water. The world war conditions emphasized the importance of this auxiliary means of transportation. Much attention has been given recently to the design of vessels, and screw propellers placed in tunnels are proving more efficient for shoal water navigation than the old paddle wheel steamers, though many of these are still in effective use. The greatest cargo ever moved at a single time was moved by a towboat of the tunnel type. Attention has been given to the modernizing of terminals and rail connections. The connection of isolated, disconnected channels to make through channels of the needed depth is now going on. Many problems of river regulation have yet to be solved.

Professor J. H. Pound showed the remarkable development of pipe-line transportation of natural gas, oil and gasoline during 1929–31, a development so important as to threaten seriously the prosperity of the railroads in the regions affected. Gasoline pipe lines of lengths even up to 1,400 miles have been found profitable and this even in cases where the supply is known to be of limited duration. The engineering features of the construction of pipe lines are of interest, since the lines are carried through every type of country encountered, some of it very difficult. Welding of pipes has become of importance and prevention of corrosion is an important problem as yet unsolved. Rivers are crossed on bridges, through tunnels or by laying pipe in the river bed. Since there is demand for this service, pipe lines are likely to continue to increase in spite of all obstacles.

SECTION N (MEDICAL SCIENCES)

(*Report from F. A. Moss*)

The meetings for Section N were very well attended. Programs were arranged for seven sessions, beginning with Monday afternoon and extending through Thursday afternoon. A total of 43 papers was given, representing a variety of fields. Several joint symposia were arranged, one for the Tuesday afternoon session, with the American Society of Parasitology; one for the Wednesday afternoon session on the "Growth of Individuals," with Sections H and K; and another for Thursday morning with Sections H and K on "Growth." The Thursday afternoon symposium, on "The New Approach to the Problems of Mental Disorders," was arranged jointly with Sections C (Chemistry) and I (Psychology).

An excellent paper was given on Monday afternoon by Dr. H. B. Weiser, Rice Institute, on the colloidal theory of gall-stone formation. He showed that gall-stones of the "pure cholesterol" type are formed in the absence of inflammation, while the "layered" stones are associated with inflammation. He demonstrated the chemistry by which stones of a non-inflammatory origin develop.

The program for the Tuesday morning session was prepared by Dr. Musser, of the Tulane Medical School. The paper on "Allergic Nephritis," by Dr. Charles W. Duval, showed that just as we can get allergic reactions in the skin and subcutaneous tissues, so these reactions may be produced in the kidney and cause an acute nephritis. Dr. Harley N. Gould showed that the nationality of ancestors has a very slight influence on the age of onset of menstruation in mothers and daughters. Those of Northern European descent have a later age of onset of menses than those of Southern European descent. The mean age of mothers at the time of first menses is 13.99 years, whereas the mean age of daughters' first menses is 13.61 years; or the daughters menstruate about three and one third months earlier. His study was based on students of Sophie Newcomb College. In this same program, Dr. Leon J. Menville, of the Tulane Medical School, presented the results of a study which he had been making on the gastro-intestinal activity of rachitic rats. In every instance, he found that the food column reached the caecum earlier in rachitic rats than in normal. He found that lack of Vitamin D influenced the peristaltic movements. At this session the address of the retiring vice-president, Dr. Louis B. Wilson, of the Mayo Clinic, was given. It will be reproduced in an early issue of SCIENCE.

The Tuesday afternoon joint session with the American Society of Parasitologists was devoted to parasitology of medical interest and consisted of five papers—one by Dr. Robert Hegner, of the Johns Hopkins University, on "Amoebiasis in Panama"; one by Dr. Walter E. Dove, of the U. S. Department of Agriculture, on "The Transmission of Endemic Typhus"; and a very excellent paper by Dr. C. W. Stiles on "The Present Status of Hookworm Disease in the United States." Dr. Stiles emphasized the fact that the job of eradication is not yet completed and proposed a practical method for attacking the job. He also developed the point that hookworm disease impairs mental capacity, and that the mental condition improves following treatment. Dr. Paul D. Lamson, of Vanderbilt University, gave a report of the studies which he had been making on the use of various drugs in the treatment of intestinal helminth infestations, and Dr. G. F. Otto, of the Johns Hopkins University, summarized a study which he has been making on "The Ascaris and Trichuris Infestations in the Southern United States."

The Wednesday morning session was given over to the symposium on "The Effects of Drugs and Internal Conditions on Behavior." Dr. Gilbert J. Rich demonstrated that there is a close relation between internal chemistry and personality and that such a relationship can now be outlined in its more general principles. Dr. Joseph G. Yoshioka, of Yale University, concluded from a study which he made, using rats as the experimental animals, that injections of an extract from the anterior lobe of the pituitary gland markedly decreases the restless activity of rats. Dr. Thelma Hunt, of George Washington University, demonstrated that fatigue can be measured by the decrease in the carbon dioxide combining power of the blood. She also showed that the onset of fatigue can be delayed by injecting adrenalin. Dr. J. A. Glaze, of Kansas State Teachers College, found that prolonged fasts cause a decrease in efficiency of the higher psychological processes during the period of the fast, but that mental efficiency is increased following short fasts. Dr. Katharine Omwake, Agnes Scott College, found nervous stability was lowest after two hours of sleep and that it increased directly with the length of the period of sleep. Dr. Frederick J. Cullen, of the U. S. Department of Agriculture, showed how his bureau had succeeded in discovering a number of fraudulent remedies and in removing them from the market.

On Wednesday afternoon and Thursday morning joint symposia were held with Sections H and K on the subject of "Growth." (See the report of Section H.)

On Thursday morning there was also held a symposium on "Nervous Disorders." Mr. Harry F. Hubbard, of George Washington University, pointed out the fact that alienists are constantly disagreeing concerning the sanity of criminals, and that the lack of agreement was largely due to the subjective methods used in diagnosis. He emphasized the need for the same objective methods in psychiatry which the other sciences have found so helpful. Dr. Fred Eberson, of Mount Zion Hospital, reported a convincing piece of work on the isolation of the organism causing infantile paralysis. Dr. Leon Gordon, of George Washington University Medical School, gave a report on more than one hundred cases of birth injury and showed how idiocy, epilepsy and other mental disturbances follow in its wake. Dr. M. L. Townsend, of Chevy Chase Sanitarium, showed how the removal of focal infection benefits patients suffering from mental disorders. He found this to be especially true in the case of the manic-depressive psychosis. Dr. Lowell S. Selling, of the Institute for Juvenile Research, found that environment was the chief factor in producing automobile thieves. He found the intelligence of the thieves slightly below normal but not markedly so. He was unable to disclose any emotional abnormalities of importance in this group.

The Thursday afternoon session was devoted to a joint program with Sections C (Chemistry) and I (Psychology), on the symposium subject, "New Methods of Approach to the Study of Mental Disorders." Dr. Abraham Myerson, of Tufts Medical College, showed how brain activity can be studied objectively by puncturing the carotid artery and jugular vein and making comparative analysis of the bloods thus obtained. He found that when the patient is unconscious as a result of anesthesia the brain uses very much less sugar than normally and that during consciousness the brain uses more sugar than either the arm or the leg. The chief contribution of his paper is that it affords a simple scientific method for studying the chemical activity in the living brain. Dr. F. A. Moss, of George Washington University, showed that all basic progress in psychiatry had been made by materialistic methods and that if psychiatrists hope to make any more worth-while discoveries they must go back to the laboratories. Dr. G. Holmes Richter, of Rice Institute, demonstrated how colloidal chemistry might explain the so-called "functional" psychoses, and he indicated that the correct method of treating such disorders was by giving some drug to restore the colloidal chemistry of the brain cells to normal. The papers on this program stressed the point that the bodily condition on which the disorder depends should be of much more concern to the psychiatrists than the mental symptoms which the patient manifests as a result of the disorder.

SECTION O (AGRICULTURE). **AMERICAN SOCIETY OF AGRONOMY. *SOCIETY OF AMERICAN FORESTERS. **AMERICAN SOCIETY FOR HORTICULTURAL SCIENCE. †POTATO ASSOCIATION OF AMERICA. GENETICISTS INTERESTED IN AGRICULTURE. CROP PROTECTION INSTITUTE.

(*Reports from P. E. Brown, G. H. Lentz, H. B. Tukey, H. C. Moore, Jay L. Lush and Paul Moore*)

Section O held a joint session with the Geneticists Interested in Agriculture and the American Society of Agronomy on Monday afternoon, the program consisting of a symposium on the "Genetics of Cotton Improvement." On Tuesday joint sessions were held in the morning and afternoon with the American Society of Agronomy, and thirteen papers were presented, dealing mainly with the use of fertilizers on southern soils. Dr. F. E. Bear presented some new and interesting suggestions relative to the selection of fertilizers of certain formulas for different crops and varying soil conditions and pointed out the variations in the effects of fertilizers when made up of different materials. He predicted that fertilizers of the future would be required to contain more than nitrogen, phosphate and potash, and to show the content of other necessary plant food constituents, such as Mg, Ca, S, etc., in the formulas. Other papers dealt with fertilizer effects on corn, cotton, oats, sugar cane and other crops grown on individual soil types in various states, the results secured with any fertilizing material being shown to depend primarily upon the soil type. The influence of fertilizers on cotton root rot, on the time of maturity and boll characters of the cotton plant and on the decomposition of cane trash in the soil was discussed. The use of chemical tests to determine phosphorus needs of soils, the nitrogen problem under semi-arid conditions and factors influencing the production of flax fiber cells were other subjects presented. On Tuesday evening the joint dinner with the American Society of Agronomy and other associated societies was held. The address of the retiring vice-president for Section O, Dean W. C. Coffey, of the University of Minnesota, was given at the dinner, the subject being "The Interrelationship of the Biological and Social Sciences in Agricultural Education."

The Society of American Foresters met on Tuesday, Wednesday and Thursday (December 29, 30, 31, 1931) with an attendance of 101 members and 48 guests, of whom 16 were ladies. The program dealt primarily with forest economics, taxation, forest finance and forest revenue. A symposium devoted to "Forestry in the South" brought out the possibilities of practicing forestry in this region. Invitations were extended to lumbermen to attend the meeting, and several of those present contributed to the program. Attention was called time and again for the need of more complete cooperation between the foresters and the timberland owners and operators.

A harbor boat trip, furnished through the courtesy of the New Orleans Dock Board, gave the delegates a respite from the indoor sessions and afforded them a chance to view the city's dock facilities.

President-elect C. M. Granger called attention to some of the problems confronting the Society, and made a plea for continued cooperation on the part of all the members. Congressman Scott Leavitt, of Montana, a former forest supervisor in the U. S. Forest Service, told the members of the legislative measures pertaining to forestry now before Congress, and mentioned briefly his efforts in having forestry legislation enacted.

Fifteen formal papers were delivered on Tuesday and Wednesday. At the business session the report of the Forest Types Committee was presented. The *Journal of Forestry* will publish most of the papers which were presented.

The all-day field trip to Bogalusa, Louisiana, in which over 100 persons took part, was probably the outstanding part of the program. The sawmill, nursery and numerous plantations of the Great Southern Lumber Company were visited.

A tour of the pine plantations was made under the guidance of P. C. Wakeley. Survival, height and diameter growth of various aged stands were observed, and the results of using different planting methods and different grades of nursery stock were studied. Attention was called also to the natural reproduction, over some 10,000 acres resulting from the 1920 seed crop. All the plantations and young growth are protected from fire and grazing and show remarkable growth. Mr. P. V. Siggers, of the Bureau of Plant Industry, explained his field studies of brown spot needle blight of longleaf pine.

The twenty-eighth annual meeting of the American Society for Horticultural Science was held in thirteen regular sessions and an additional joint session with the American Society of Plant Physiologists, and included the presentation of 157 papers, representing the largest number in the history of the organization. The general trend of research in horticultural problems is to be seen in the continued interest in tree fruits along the lines of chemical composition and fruiting, stomatal behavior under varying conditions of moisture, growth and humidity, effects of light upon color development of fruit and respiration of fruits in storage at varying temperatures, in the increased attention to problems of the peach along similar lines, in the interest in physiological problems of raspberries, strawberries and grapes, in the continued activity in vegetative propagation of woody plants, in the fundamental nature of scientific effort with vegetable crops, in the direction of scientific effort upon ornamental horticulture and in the definite attainment of scientific rank by investigation with floricultural plants.

In discussions of policy and general business a committee was appointed to urge and cooperate in the cataloguing and indexing of state experiment station publications as well as of U. S. Department of Agriculture publications by the U. S. Department of Agriculture, so that all literature upon agricultural subjects may be brought together in quickly accessible form. It was also pointed out that journal publication had definite advantages, that publication in experiment station bulletins had certain limitations, and that it would seem a constructive and economic step for stations to purchase space in journals in some cases rather than to continue publication in their own series.

The address of the retiring president, Dr. T. H.

McHatton, of the Georgia State College, reviewed the evolutionary changes in horticultural work. Dr. H. A. Jones, of the University of California, Davis, California, was elected president for the year 1932.

The attendance at the New Orleans meeting of the Potato Association of America was not large, but unusual interest was shown in the program. Six papers, dealing with certified seed and potato fertilizers, were presented by Southern experimenters and were of special interest to Southern workers.

Reports on the cooperative potato-breeding project presented by the geneticist of the Office of Horticultural Crops and Diseases, U. S. Department of Agriculture, and by plant breeders of several experiment stations, showed marked progress in 1931 in developing new seedlings. One seedling, the Katahdin, has proven exceptionally good and may replace some of the late standard varieties in several states. The Potato Association of America highly endorsed the work done by the U. S. Department of Agriculture and the Experiment Stations in developing new varieties of potatoes, and passed resolutions asking that more funds be appropriated for potato-breeding work.

Reports from New York and Maine on the development of late blight immune varieties through breeding work were enthusiastically received by both Northern and Southern growers. Evidently the prospects of producing in the near future varieties of potatoes resistant to some of the common diseases are very bright.

Seed potato certification received special attention by the delegates.

The Geneticists Interested in Agriculture met on Monday for a symposium in the forenoon on the "Genetics of Bee Breeding" and a symposium in the afternoon on the "Genetics of Cotton Improvement." The peculiar method of inheritance in Hymenoptera alters the relative importance of sisters, offspring and aunts as indicators of the genetic constitution of the queens and drones to be selected. The difficulty of controlling matings, which has been a serious handicap in the past, seems in a fair way to be solved. Several men with long experience in practical bee-breeding were present and contributed to a lively discussion as to what the ideals of the bee breeders should be and the problems wherein more genetic knowledge was felt to be urgently necessary.

The afternoon meeting on the genetics of cotton improvement was largely concerned with the possibilities involved in crosses of varying degrees of wideness. It was generally felt that extremely wide crosses offered little promise of improving the present varieties, but that crosses of nearly related varieties offered a fruitful field for further improvement. The rapid development of mechanical harvesting of cotton has in some sections made it imperative to breed a type of cotton better adapted to this purpose. The type of mechanical harvesters so far in use and the steps being taken to breed varieties to meet this new need were discussed.

The members present voted to merge the organization of the Geneticists Interested in Agriculture into the newly formed Genetics Society of America. Dr. R. A. Brink, of the University of Wisconsin, was selected to represent the interests of this group during this merging.

The Crop Protection Institute had its annual meeting on Wednesday, December 30. Professor W. C. O'Kane, chairman of the board of governors, gave a brief survey of some of the year's work. He reported no change in the type of work and only a slow change in the personnel of the board, which was responsible for the general plans of the institute. Projects are still managed through committees.

While the institute had some curtailment of funds, it had under all conditions maintained its work well, and the present projects were even more significant than some of past years. More industrial companies are making use of the institute. A survey through one of the projects developed the fact that more than ten billion gallons of spray material are applied to commercial plantings each year, this being exclusive of spraying in home gardens, greenhouses and plantings too small to be listed, or applications to live stock or household uses. While some of the projects had been concluded, others were still in development, and several new fields were just being entered.

Paul Moore, secretary-treasurer, reported receipts of $44,159.84 and expenditures of $47,529.22 during the fiscal year, with a balance on hand at the time of the meeting of approximately $19,600.00.

SECTION Q (EDUCATION)

(*Report from W. L. Uhl*)

The sessions of Section Q were on Monday, Tuesday and Wednesday. The address of the retiring vice-president for the section, Professor Leonard V. Koos, of the University of Chicago, was given on Tuesday evening at the joint dinner of Sections I and Q, Phi Delta Kappa and Kappa Delta Pi. Professor Koos outlined the national survey which is being made of secondary education in the United States. Interesting papers were developed at other sessions. Dr. J. E. Adams reported an acceleration experiment in which it was found that brilliant pupils who skipped grades made better records during the year after they skipped than they had made in previous years. Classroom experimentation in the use of portable typewriters was reported by Dr. Ben D. Wood and Professor Frank N. Freeman. The use of typewriters in the elementary school led to an increased amount of written work of improved character and caused no injury to progress in any of the school subjects. Professor F. A. Ford's study indicated that in many public schools the better a child's mental ability the less favorable is his school success in relation to other pupils. Papers indicating the effects of studying science were given by Dr. G. S. Craig, Dr. G. W. Haupt, President A. O. Bowden, Dr. Otis W. Caldwell and Mr. G. E. Lundeen. These papers indicated that there is little or no relation between the amount of schooling of the common population and the prevalence of their beliefs in magic and superstition. They indicated also that when science teaching is organized with direct reference to certain unfounded beliefs there is an improvement of about 33 per cent. in the eradication of these beliefs as compared with their eradication when such training is not specifically directed against superstitions. Dr. H. W. James and Dr. J. B. Maller reported upon problems of character education. Both papers called attention to the complexity of conflict situations and also to the varying judgments of both students and adults about the proper courses of action in conflict situations. The priority of New Orleans in educational developments was reported by Professor Stuart G. Noble. Mr. Irving P. Foote discussed the tenure of high-school teachers in Louisiana. The value of the amount of high-school Latin as a method of selecting applicants for college was indicated in Mr. E. L. Clark's paper. Diagnostic and testing work was reported upon by Dr. C. C. Ross, Professor H. H. Remmers and Mr. C. E. Prall. Studies of the difficulty of getting meanings from the printed page were reported by Dr. Ernest Horn and Professor A. S. Barr. Dr. Horn pointed out reasons why the present vocabulary studies have failed to indicate, more fully than they have, the reading difficulties which children encounter. Dr. Barr reviewed experimental studies which he has been conducting with special reference to the vocabulary difficulties in American history. Dr. S. L. Eby reported a detailed investigation of students' high-school marks and college marks for an entire graduating class from the University of Cincinnati. The relation of various entrance requirements to subsequent university success in a school of engineering was reported by Professor August Dvorak. He showed that the regression equation clearly predicted subsequent suspension from the school in case of 60 per cent. of the actual failures. The relation of physical to mental development in children in four different countries was given by Dr. S. A. Courtis. Professor H. H. Remmers, in stating the results of measurement in high-school English, showed that the highest pupil in a high school of low standards was found to be below the lowest pupil in a high school of high standards. He concluded that the knowledge of the school's relative standing was necessary in judging the pupil's achievement in English. Professor W. L. Uhl emphasized the lack of measurement of such mental functions as social competence, creative work and esthetic experiencing, in the present-day standardized tests. Dr. Grace O. McGeoch reported data which indicate that neither the whole method nor the part method is inherently superior for any individual, but that the relative efficiency of either method is a function of a number of factors. Dr. T. E. Newland presented an analysis of illegibilities in handwriting from the lower grades to adulthood. He found that there are typical illegibilities for certain letters, that these illegibilities tend to increase with age and that remedial and preventive work can be arranged greatly to reduce these illegibilities. The legislative as well as professional difficulties of arranging sabbatical leave for public-school teachers was reviewed by Professor W. A. Cook. He reported also present-day practices, what teachers do while on leave and the effects of the leave upon their subsequent work.

RELATED TO THE ASSOCIATION AS A WHOLE. ** SOCIETY OF THE SIGMA XI. * AMERICAN NATURE STUDY SOCIETY. ** HONOR SOCIETY OF PHI KAPPA PHI. †GAMMA ALPHA GRADUATE SCIENTIFIC FRATERNITY. SIGMA DELTA EPSILON GRADUATE WOMEN'S SCIENTIFIC FRATERNITY

(*Reports from Edward Ellery, Jennie Hall, Roy M. Peterson, H. R. Nelson and Kathryn Knowlton*)

The thirty-second annual convention of the Society of the Sigma Xi was held in the Hotel Roosevelt, New Orleans, on December 29. Reports of the officers were received, and the following actions were taken: (1) That the executive committee be empowered to recognize in a suitable way research work done in institutions in which there is no chapter; (2) that the society do not place itself on record at the present time as favoring federal grants for research; (3) that chapters be established at Western Reserve University and at Princeton University; (4) that the following officers be elected: *President,* Louis B. Wilson, Mayo Foundation; *secretary,* Edward Ellery, Union College; *treasurer,* George B. Pegram, Columbia University; *member of executive committee* (for 5 years), H. V. Wilson, North Carolina; *member of executive committee* (to serve the unexpired portion of Dr. Louis Wilson's term), A. O. Leuschner, University of California; *alumni member of executive committee,* Henry G. McKnight, District of Columbia.

An innovation this year was the substitution of a buffet supper for the annual dinner. The supper followed the convention and gave opportunity for a discussion on the part of delegates of chapter affairs and the conduct of the society's business. The tenth annual lecture, under the joint auspices of the association and the society, was given in the Municipal

Auditorium by Mr. C. F. Hirshfeld, chief of research of the Detroit Edison Company (see General Sessions).

The meetings of the American Nature Study Society on Monday, Tuesday, Wednesday and Thursday offered a group of about seventy, who were in attendance, a most interesting and varied as well as profitable program.

The speakers of the Monday morning session, which was arranged by the New Orleans branch, described and illustrated the natural environs of New Orleans so vividly and so well that many of the audience were lured to nature in spite of excellent programs offered later in the week. On Tuesday morning the Webster Groves Branch, with fifteen papers, outlined the excellent group work accomplished in various fields included by that chapter of the society. Tuesday afternoon was given over to the study of nature and science in the schools of the country. Seven very able papers were given at this session and many valuable ideas were exchanged through discussion which followed the papers. Nine original contributions of various phases of natural history were given to the audience on Wednesday morning, when animated discussions arose which for a time threatened the postponement of a final business meeting.

On Tuesday evening the president, Mr. A. F. Satterthwait, of the U. S. Entomological Laboratory at Webster Groves, Missouri, presided over a banquet where a large group feasted and visited and where a few earnest members responded to toasts. During the program which followed the banquet, the newly organized New Orleans and New York branches were formally recognized by the society when their delegates were tendered bouquets of roses. The evening's entertainment was finally delightfully climaxed by Stanley C. Arthur's lecture and five-reel motion picture film, entitled "In Audubon's Louisiana." On Thursday morning the group was again entertained by the New Orleans branch, who conducted a tour to the beautiful school gardens of the city.

The business meeting on Monday afternoon was devoted to the adoption of a new constitution for the society and to other methods concerning better functioning of the organization. At this meeting it was voted to hold a meeting at Syracuse in June. Mr. Satterthwait was reelected president, Russell F. Lund, of the Connecticut Department of Education, was elected vice-president, and Jennie Hall, of Minneapolis, was continued as secretary-treasurer.

Before separating for personal interests and duties many members of the American Nature Study Society expressed the opinion that the twenty-fourth annual meeting had been a most happy and profitable one.

The twelfth biennial convention of the Honor Society of Phi Kappa Phi, which has chapters in forty-five educational institutions, was held at the Bienville Hotel on December 28 and 29. The principal address was given by the retiring president general, Dr. Roswell G. Gibbs, of Cornell University. On the recommendation of the executive council it was voted to establish immediately two fellowships of the value of $500 each, which will be available for advanced study to members of the society who graduate this year. Provision was made for building up a further endowment fund for fellowships, so that the number available will gradually increase, as well as a publications fund. The constitution was amended to provide for active life memberships. Officers were elected as follows: *President general,* Dr. Aven Nelson, University of Wyoming; *secretary general,* Dr. C. H. Gordon, University of Tennessee; *regent general,* Dr. E. C. Auchter, Bureau of Plant Industry, U. S. Department of Agriculture; *historian general,* Dr. J. S. Stevens, University of Maine; *editor general,* Dr. Roy M. Peterson, University of Maine.

The Gamma Alpha Graduate Scientific Fraternity held its annual council meeting and convention on Tuesday and Wednesday. The meeting of the council was largely devoted to considering policies of fraternity expansion. A method of raising funds for the payment of the councillors' transportation expenses to the annual meeting was devised and submitted to the chapters for ratification. This action was taken with a view to forming a closer bond between the various chapters and with the hope that the annual meetings will become a more effective means of exchanging ideas and transacting business. Forty members were present at the reunion breakfast on Wednesday morning. The officers for 1932 are: *President,* Rodney W. Babcock; *secretary,* H. R. Nelson; *treasurer,* S. P. Miller; *editor,* Carlton F. Scofield; *recorder,* D. S. Welch.

Sigma Delta Epsilon, graduate women's scientific fraternity, held two meetings. On Tuesday morning a breakfast was arranged at the Louisiana, to which all women interested in science were invited. Forty-five members and guests were present, representing about thirty-five institutions. Dr. Elinor H. Behre, of Louisiana State University, gave an interesting talk on the development of their summer biological work. The annual convention of this organization was held at the Orleans Club, following a second breakfast. Dr. Frances G. Wick gave a brief discussion of "Luminescence," mentioning some possible future developments in the field of lighting. The following national officers were elected for 1932: *President,* Erma A. Smith, Iowa State College; *vice-presidents,* Hazel Craig, Brown University, and Maude Bennot, Northwestern University; *secretary,* Agnes Zeimet, University of Wisconsin; *treasurer,* M. Helen Keith, University of Illinois.

SCIENCE

VOL. 75 FRIDAY, FEBRUARY 12, 1932 No. 1937

The University and the Medical Profession: PROFESSOR JAMES EWING 173

Roosevelt, the Naturalist: DR. C. HART MERRIAM 181

Obituary:
Robert DeCourcy Ward: DR. W. J. HUMPHREYS. *Recent Deaths* 183

Scientific Events:
The Banting Research Foundation; Exhibition of the Royal Meteorological Society; The Westchester Institute of Sciences; The Field Museum of Natural History; The Engineering Societies Library 185

Scientific Notes and News 188

Discussion:
Discovery and Discoverers: DR. ARNOLD C. KLEBS. *A New Autotrophic Bacterium which Oxidizes Ammonia directly to Nitrate and Decomposes Petroleum:* DR. CHAS. B. LIPMAN and L. GREENBERG. *Growth Inhibition of Potato Sprouts by the Volatile Products of Apples:* DR. O. H. ELMER. *Breaking the Dormancy of Tree Seedlings by Chemical Treatment:* WILLIAM C. BRAMBLE. *Dust Particles:* JEROME ALEXANDER. *The Nervous Control of Hematopoiesis:* DR. JOSEPH KRAFKA, JR. *The Position of Wood in Beaver Dams:* EDWARD R. WARREN 191

Special Correspondence:
A New Connection between Magnetism and Electricity: ALEXANDER W. STERN 195

Scientific Apparatus and Laboratory Methods:
A Simple Apparatus for Mercury Distillation: DR. MAX KLEIBER. *Improved Staining Techniques for the Demonstration of Non-acid-fast Tubercle Bacilli and Granules:* ELEANOR G. ALEXANDER 196

Special Articles:
Poliomyelitis as an Essential Nerve System Disease throughout its Course: DR. HAROLD K. FABER. *The Non-identity of "Pure" and "Isoelectric" Gelatins:* PROFESSOR ROGER J. WILLIAMS, LEO FRIEDMAN and DON M. WOODS. *Air Filtration in Bacteriological Laboratories:* NATHAN R. SMITH 198

Science News 8

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THE UNIVERSITY AND THE MEDICAL PROFESSION[1]

By JAMES EWING, M.D.

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THE university has always been the best expression of the intelligence of a community. The university first appeared in ancient Greece, later became highly developed in Alexandria, survived the upheavals of the Dark Ages, and under Moslem influence reappeared at Salerno in 1120, where it proved to be the first step toward the revival of learning and the Renaissance, while in later centuries it has been the chief agent in the advance of knowledge. There must be some very substantial qualities in an institution which has survived all these vicissitudes, and it is worth while inquiring into the nature of the qualities. What is a university and what is the university idea? The university idea involves the cooperative intellectual and moral effort to collect, disseminate and apply knowledge for man's needs.

Cooperation between the various branches of knowledge is perhaps the first essential of a university and becomes more necessary as the complexity of problems increases. Most of the great advances in medicine have resulted from the reflection of new knowledge in one science upon the problems of another. In order to have cooperation, the men in a university must have the social instinct and understand the significance of the social relation. Here, at the outset, is a very difficult and complex problem, how to secure voluntary united effort among scholars, without interfering with individual effort and ambition. It can not be secured by mandate, but it may be conserved by deliberate efforts of university organizers. It must be based on mutual respect, character and community interest. Experience shows that institutional pride, a sense of ownership in one's own products and partnership in the achievements of one's colleagues, all directed toward common ends, have been the most efficient factors in securing cooperation. A sense of loyalty and intellectual honesty belongs to cooperative scholarship. There are many instances where the influence of a commanding personality in a university, an intellectual or official leader, himself exemplifying the desired qualities, has secured the highest type of loyalty and efficiency. It has been said that every great institution is but the shadow of some man. It is the belief of many that in the choice of a university faculty, one will go further by choosing men rather than experts.

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[1] Anniversary address, New York Academy of Medicine, November 5, 1931. The historical basis of many of the statements in this address has been omitted from the present copy. The full text may be found in the Bulletin of the Academy, January, 1932.

Thus, the very first problem of the university encounters that most fundamental question of morals. One must therefore stress the moral aspect of university organization to the fullest limit. In the advance of knowledge, the end must not justify the means, for if there are not moral standards in a university where are we to find them? The church preaches them, the law attempts to compel them, business often flouts them, but the public conscience expects the exhibition of them by men associated in a university. The moral law applies to the officers of a university quite as much as to the active workers. I doubt if any university can go far under the leadership of a man who has only a loose sense of right and wrong. One must practise the cardinal virtues before attempting to cultivate genius.

In order to preserve loyalty and morals in a university, the organization must be designed wisely for that purpose. The earliest schools solved the difficulty by having very little organization and that in the hands of students and teachers. It was an ideal method, and worked well, but is too cumbersome for modern conditions. Other schools were supported and directed partly by the state and some were chiefly products of the church. History shows rather clearly that the church has never been very successful in conducting universities, especially medical schools. One may well wonder why the medicine of the monks was not more productive, since they should have been well provided with leisure, loyalty and morals, but we have modern instances of failure by the church in the same field. In modern times the state has appeared at its best in university affairs, especially in Germany and France, by providing funds, and creating a group of experts in university organization, who generally wisely kept their hands off the internal workings of the university.

For many centuries and after many digressions, the opinion has strengthened that the essential policies of a university should be determined by the scholars themselves, or through their agents, while non-professional officers should deal only with finances. It is a question of deciding complex and technical problems by men who have first-hand knowledge. The best results have followed this policy, as with the great German universities of the last century.

When scholars have been chosen for personal and moral qualifications, it can not fail to work well. If they are not so chosen, the whole structure must be faulty and no scheme of organization will correct the fault.

Combined direction by a body composed of laymen and scholars has long been active in the University of London, with excellent results, but the questions submitted to this body are of a general nature. This body actually inspects the workings of various medical schools under the University of London, and adjusts grants to the schools according to its best judgment, but for the past forty years it has taken no part in the choice of the faculty. There have been no conflicts in the working of this organization, and it is needless to say that the men composing the body possess high moral and personal qualities and understand the university idea.

In America there is a notable lack of uniformity in the executive management of university medical schools and frequently a failure to recognize the best university standards. Experience shows that most of the minor and some major troubles arise just at this point, where in the interests of executive efficiency valuable traditions are neglected and an important source of loyalty is sacrificed. Owing to the executive indisposition of scholars, the president and his appointee, the dean, have sometimes been led to exercise plenary powers and even to assume professional and spiritual leadership. Under some conditions such expedients may have been necessary, yet an energetic president and an aggressive dean, subordinating the faculty, are better suited to a business organization than to a university. The deanship implies maturity and the qualities of leadership, and these are best judged by scholars, in whose hands the nomination of dean should rest. A president possessing broad vision and a tactful dean cordially cooperating with the faculty furnish ideal conditions, and unless these are fully met many believe that the office of the dean should be abolished and his executive function filled by a lay officer. The university idea is comparatively new to most American medical schools, while practical problems have been very numerous, and to these facts we may attribute our failure to reach a real university standard in organization.

Universities have traditions to which they cling tenaciously and which are often very valuable possessions, but may become serious handicaps. These traditions are the result of long experience and careful thought by leaders, past and present, and they generally dominate the organization and activities of the schools. They make character and quality in an institution. They enable the school to weather storms of criticism and the assaults of reformers. They conserve the self-confidence and loyalty of the scholars and students, and they offer a splendid example of mental and moral equilibrium to other governmental and social institutions. They tell the iconoclast that there are immutable standards of right and wrong, that past progress is substantial and the future full of promise. Traditions are strongly entrenched in Germany, France and England, where they are hedged about by complex barriers, and it is so difficult to change them that few attempts are made to do so. Rigid adherence to theory and prominence of clinical study are characteristic of French schools, thoroughness and originality of the Germans, and solidity and critical ability of the English. The subtle influence of tradition is best seen at Oxford and Cambridge, where the English youth acquires a stability and refinement of character hardly equalled elsewhere. Most observers find the source in the constant contact of young men with ancient halls, sensible of influence, still potent, of past masters and disciplined in the old well-tried methods of thought, study and conduct. Yet the efficiency expert would tear down the old mouldy crumbling halls, erect modern hygienic buildings, throw out the useless readers, abolish the ancient and superfluous Regius professorship in medicine, reorganize the cumbersome government, abolish old ceremonies to save time, and generally ruin the whole splendid structure. American universities also are old enough to have traditions and American scholars cling to them firmly, but we are not so sure of their value. We permit changes and experiments, small and great, on slight provocation, and rejoice to see the survival of the good after periods of chaos. The great danger of traditions is scholasticism, but history shows that the taint of scholasticism survives reform and can only be reached by intelligent appeal to the morality of scholars.

Among the time-honored traditions of universities are nomination of appointees by one's peers and life tenure of office for established scholarship. The actual power of appointment may well rest in other hands. Here lies the mainspring of loyalty and morality. These standards assure that appointments will be made on merit, as judged by personality and a record of achievement. Without them advancement may be sought by salesmanship and political and social influence, and made in accordance with the swings of fashion by any one who happens to be in authority. In France, England and Germany the available candidates have passed through a long series of qualifications by which they advance step by step to the higher positions, a method which encourages consistent work and eliminates the adventurer. In England, where the method is followed rigidly, some men may be advanced on length of service without corresponding ability, but prominent British educators assert that the advantages even of this system far outweigh its faults. The demotion of a professor in Germany would be regarded as a calamity subject to searching investigation, and such an event has virtually been unknown. While age is an uncertain standard, retirement at 65 or 70 years is generally a wise provision.

While the American universities generally aim at the highest standards there is a lack of the rigid barriers and traditional safeguards maintained in the older European universities. It is not surprising, therefore, that there have been occasional violations of established precedent, which it is best to regard as incidental to our unsettled conditions, to the rapid growth of university faculties and to the necessity of frequent changes. It is not wise to minimize their importance, because they lessen the loyalty and morality of scholars, and they tend to sharpen the political sense of young doctors who are entering a university career. Human nature may not change much, but conditions do. Forty years ago I never knew of any laboratory worker whose work was definitely influenced by political considerations, but to-day the younger men discuss with the utmost frankness the political significance of their researches, utterances and contacts. The responsibility for these changes is very great and unless they are checked American medical scholarship will suffer lasting harm. It is not difficult to trace these changes to unfortunate practices which have survived recent reforms or have even resulted from them.

If contracts made by one administration are overlooked by a succeeding administration, one must infer that precedent is not well established in that school.

If the leading members of a faculty are forced out for the benefit of the favored healer of a high political official, one must conclude that the basis of such a university is very unstable.

If all the higher positions in a faculty are declared vacant in order to make way for a cherished reform, one must ask whether the end justifies the means. The violent dislocation of established teaching staffs is an exceedingly drastic measure which many a man with fine sensibilities would hesitate to advise or undertake. Even Maria Theresa hesitated at such a step.

If authority is given to one man to choose an entire new faculty on his own knowledge, aided by those whom he chose informally to consult, the question immediately arises: Why depart so widely from safe precedent and why not divide the authority among those who must later accept official responsibility?

If the policies of university medical schools are wisely based on traditions and are safely determined only by responsible experts with long experience, is it not clear that interested laymen run great risk of doing harm when they undertake to direct or control these policies?

To our European colleagues these violations of university methods in America appear to be inexplicable. Many have assured me that they can not exist in Germany, France or England, and they regard them as a grave danger to university prestige in America. Thus, if established principles are neglected, even in good hands, and in spite of good intentions, expediency beclouds judgment, opportunity outrides tradition and ambitions replace ideals.

The foregoing incidents lead directly to another paramount factor in American medical education, the influence of organized philanthropy. Every one recognizes that the great foundations have been directed with wisdom, mainly by scholars of high repute, and that their policies have been based on the investigations and opinions of experts in many fields. Probably no new American activity has received more thorough scrutiny and deliberation. The *British Commission on Education* has for centuries conducted studies on educational problems, but in America there was no such group of experts on whom to rely in the solution of new problems. In creating such a group the foundations have done not the least of their services. It is not surprising that the foundations have been accessible to innovations, earnestly pressed by their proponents, but not fully understood or approved by the great body of scholars. The project of full-time clinical service is one of these innovations.

University men can offer no objection to the trial of this experiment, but they have regretted some of the conditions under which the experiments have been conducted. We trust that the results of the trial will be viewed with scientific courage.

The central idea of providing young men with opportunities for medical study free from financial worry was excellent and was wisely met by offering substantial salaries for this purpose. It was an entirely different matter to prevent university professors from overcharging their patients and neglecting their duties, for which the proper remedy was dismissal or moral suasion. The error was made of attempting to accomplish both these worthy objects by the same remedy and it has led to serious changes in the whole organization of medical teaching, some of which are not working well.

The first major consequence was the super-clinic with its enormous budget, calling for large sums of money which many think could be used better in safer projects. The most urgent need of medical education was larger support for the medical sciences, to enable professors and their mature assistants to live properly on their salaries. It was soon found that one had to pay the market price for suitable heads of the clinical departments, and when salaries comparable to those of bank presidents were added to the lure of scientific opportunities, the scheme lost much of its idealistic color. The old-fashioned laboratory man, never having sat at the seat of custom, did not begrudge the liberal pay of his more fortunate colleagues, but he was startled by the assumption that competent chemists, bacteriologists and pathologists could be found to work under the clinical leader, and he became alarmed to find his own traditional field of work dwarfed by his expansive neighbor. Thus far the only feature of the super-clinic which has fully materialized is the budget.

The full-time system has placed a premium on research and a discount on clinical efficiency. The responsible heads of clinical departments should be masters of their subjects, but when young men who have merely performed a creditable piece of research are given large clinical responsibilities they are compelled to learn their business at the expense of their patients. But clinical medicine can only be mastered by long years of hard experience. Thus one of the worst faults of the old proprietary school system was unconsciously reenacted. Recently more mature men have been chosen to head the clinical departments, but the choice has been determined mainly on achievements in research, and not on ability to deliver service of the highest type.

Hard times are now about to add their salutary complications, and the immediate future of full-time clinical service faces new trials. It is to be hoped that the effort to float the scheme in times of stress does not lead to further dwarfing of other activities. Certainly the plan should not be forced upon institutions, and the proponents would do well to confine the experiments to resources under their immediate control. Since the activities of the foundations exert a profound effect upon medical education, university men look to them for the finest appreciation of the university spirit.

II

The university is a place for the collection of knowledge, and it is an ancient tradition that for this purpose a great library is essential.

In the Dark Ages medicine was mainly concerned with disputes over ancient and recent texts. The art of printing let loose a flood of revisions, writings and debates, which reveal an outstanding characteristic of the medical mind. To-day an enormous volume of literature of every description from a multitude of sources crowds the ancient manuscripts into secure vaults and submerges the real progress of science. Surely a consuming fervor of debate animates the medical profession, perhaps above all others. Yet, there is a fascination about the world of letters, unrestrained by harsh facts, which appeals to every one, and inclines one to excuse the Dark Ages for their scholasticism and the modern age for its colossal libraries.

America has always indulged a feverish passion for collecting books, and we have emptied many a foreign stack and cellar to fill our shelves. The outstanding features of medical literature to-day are volume, diversity, repetition, classification, practicality, accessibility, efficiency, not unmixed with fine literary effort and finish, but brevity and directness are lost arts. Americans are the most voluminous readers and publishers in the world. The library of the New York Academy of Medicine receives annually 1,965 journals, of which 679 are American, representing all branches of medicine and its collateral sciences. We have many great medical libraries, none exceeding in scope, usefulness and value the splendid collection of this Academy.

Yet, the art of printing was not an unmixed blessing. In may fields it has become almost as difficult to get the truth from books as to go out and discover it anew from Nature. Tons of printed pages come like an ocean fog from innumerable society transactions, great numbers of papers compiled for trivial occasions, extemporaneous remarks from all classes of speakers, hastily prepared orations, interminable case reports, undigested notebooks, etc., none of which are allowed to die, owing to the ever-present stenographer, stenotype and pestiferous dictograph. The worst offender is the record-breaking investigator in the medical sciences, who serves up an endless supply of scientific tidbits. There is a well-known racial tendency to leave nothing unsaid, and an equally well-known national habit of encyclopedic display of knowledge without thought, both of which crush the honest reader. The Swiss physiologist of the eighteenth century, von Haller, was an infant prodigy, who produced 13,000 scientific papers and gave our most esteemed branch of medical science an impulse from which it is still vibrating. This is a record, and our modern contenders must not attempt to break the record. On the contrary the physician should feel a sense of responsibility every time he takes up the pen, realizing that he is about to add permanently to the mass of literature. It is now generally appreciated that the number of papers produced by an author is usually in inverse ratio to their value.

Yet, there are many gold nuggets in the sands. Scholarly text-books, authoritative systems, erudite texts and crisp announcements were never so numerous. World literature was never so easily accessible or so eagerly sought, and the written word was never a greater power in the progress and continuity of medicine.

On another side, I would enter a plea for greater appreciation and use of the scholar with broad experience and wide erudition as an efficient source of knowledge. There is a subtle power in the spoken word always missing in print. If it were not so we should abandon teachers and use only books. A half hour with Sir William Osler was worth a month in the Bodleian Library. As a matter of fact, the great bulk of effective knowledge in the world comes from conversation and deliberation with those who know. The value of such men in a university should be more formally recognized.

III

Research now occupies the center of the stage in the program of most university medical schools. Human ingenuity has been strained and material resources taxed to elicit new facts about disease. The results are most impressive, and in no other age has there been such a volume of new information about all phases of medical problems. One may perhaps also say that in no other period has available knowledge been so usefully applied, for much able effort has been directed to the dissemination of knowledge and its application at the bedside. A fine spirit of inquiry and investigation pervades the medical schools, hospitals and societies, elevates the standards of practice and curbs destructive criticism.

It is necessary to distinguish between mere observation and research, and by so doing we at once exclude the great bulk of so-called original investigation. Interesting isolated case reports, peculiar variations in anatomical findings, improvements in chemical technics, isolated findings of new chemical and physical variations in pathological processes, uninterpreted results of experiments, may educate the writer, but do not constitute investigation. True research involves the attack upon a definite problem, the setting up of an hypothesis and the demonstration of the truth of the hypothesis by adequate methods and with convincing evidence. The discovery of insulin is an example of real research and original investigation. One hastens to add that observation is the main means of discovery of medical problems, and consecutive observation has in the past furnished the solution of many. It was almost the sole weapon of the old clinicians. Research in the literature was the main occupation of medieval physicians who thumbed the medical canons for centuries without results, and it still remains a favorite pastime. The modern scholastic loves to rediscover old facts by new methods and claims that we are now engaged in quantitative estimations of the phenomena of disease. This dictum assumes that the facts are already known. There is a point in the course of most investigations where the aid of experiment is necessary, but pure experimental research on man-made problems is overdone and its results, unless closely controlled and applied, have been disappointing. This is the antithesis of the old scholasticism and shares its faults.

In recent decades the universities have lost some of their dominance in research, owing to the increasing complexity of problems and the necessity of providing men and materials on a large scale. Throughout the world there are many research institutions, private and governmental, which are contributing a very large share of medical progress, and the conditions in many of them are rather more fortunate than in most universities. Some very important medical problems are now largely in the hands of industrial concerns which handle them with fine recognition of the university spirit. Yet pure research tends to scholasticism, and industrial research has relations with commercialism, so that both these movements are regarded with anxiety by most university men who would prefer to see the universities retain a dominant position in medical research.

I mention these few phases in order to point out that knowledge makes progress in exceedingly varied and devious ways. The flower of research will not flourish in the highways and byways. Therefore any attempt to direct or coerce research according to the ideas of commissions and organizations is probably unsound. Complete freedom of thought and action are essential conditions, for it is generally the nonconformist who makes progress.

The university is a place for the dissemination of knowledge, which is equally important with its collection. Teaching in all its phases is probably the most constructive of human activities, the most effective factor in binding individuals in the social state, and the chief agent in maintaining the continuity of knowledge from age to age. The facilities for medical teaching have had revolutionary advances in the last half century, and the results are excellent. Yet, the art of teaching remains the same as ever. Its essence consists in personal contact, the spoken word, a fitting personality and the instinct of the helping hand. Here the university spirit finds some of its best expression. To cultivate the faculties of the immature mind, to give opportunity under direction and to see results, is to add something to the world which would not otherwise exist and is the chief reward of the teacher. Medical history abounds in the examples of the influence of the great teacher, extending often over several generations. Such men have been loyal friends of their pupils, and have never ceased to exert their influence to advance their associates in every proper way. They have had the ambition to produce men superior to themselves. Over against the helping hand is the idea of the big brother. Some teachers assert that they address themselves only to the best men in the class and neglect the others. Conscious of superiority, they clamp down their own ideas and methods on the brilliant student, they see their own reflection in his success, which they are very apt to appropriate, they love the ease of working with capable minds, but they contribute little that would not otherwise exist. The big brother idea has many ramifications in and out of university life, but it is contrary to the university spirit. It is a fortunate school that numbers in its staff many self-effacing, hard-working, earnest men who take pride and pleasure in seeing creative work throughout the ranks of their students and whose departments are free from dogmatism, egotism and self-assertion. Yet, I have almost never seen a department head deliberately chosen for these rare qualities. The premium on brilliancy and so-called productivity generally singles out men of quite a different type.

The study of medicine has a very high cultural value, probably exceeding that of any other department of learning. The intrinsic value of a knowledge of medical science and clinical medicine is very great, and this is the reason why it is sought by thousands of young men and women quite apart from the earning capacity and privileges which the doctorate in medicine confers. Acquaintance with the structure and functions of the human body, of the causes, mode of origin, course and control of disease, discipline in scientific modes of thought, respect for authority, consciousness of one's own limitations, are some of the qualities which generally make a knowledge of medicine conspicuous in its possessor. Physicians, who do not practice medicine have often exerted a powerful influence for good in public affairs, especially in Germany, and that influence is greatly needed with the growing complexity of the problems of modern life. Yet, modern university medical schools deny this knowledge to hundreds of applicants and thereby lose a vast opportunity to advance the standard of general intelligence and extend the influence of the university ideal. Compelling excuses are believed to exist in the difficulty of supplying adequate facilities of the best type, but the responsibility can hardly be dismissed in this manner.

There are to-day 13,000 fully qualified applicants for medical instruction in this country, but only 7,000 places available. Thus, the institution designed to supply a need becomes the chief obstacle in the way of the satisfaction of that need. Descartes has said, "If there is any possible means of increasing the wisdom and ability of mankind, it must be sought in medicine."

Fortunately, the dissemination of medical knowledge does not end with the university, which rather naively admits that it only lays a foundation. Some medical educators aim to teach as little of practical nature as possible, in which ambition they are often remarkably successful. Postgraduate education looms too large for the present-day university program, but the task is taken up by innumerable other agencies. Local, social and scientific, urban, interurban, county, state, national and international societies, journals and conferences form a vast and effective scheme for the interchange, dissemination, advancement and employment of medical knowledge. We may at least claim that in the workings of this scheme the influence of university men predominates.

IV

Finally, we come to that fundamental question, the place of utility in the conception of the university. I have ventured to emphasize, perhaps overemphasize, the idea of utility for man's needs as a guiding principle in the university program. This proposition may appear self-evident to many, but the history of medicine shows that it has been contested and often overridden at many periods, and it lacks general acceptance at the present day. During the decay of medicine and the reign of the medical gospels in the Dark Ages, it was wholly discarded and medical knowledge was sought in parchments and for its own sake. At this very time the influence which kept medicine alive was the enormous and ever-present task of caring for the sick. The growth and achievements of many knightly orders consecrated to the relief of the sick throw a splendid light over those melancholy centuries. For a very long period hospital construction, nursing and hygiene made remarkable progress, while medical science stood still. For a longer period the methods of teaching medicine were inherited ends in themselves, so cumbersome in the exclusive use of Latin, as to thwart the object that should have been in view. In the Renaissance it must be suspected that the rivalry between competing universities, some of which drew great numbers of paying students, perpetuated dogma, artificiality and institutional reputations, over utility and progress. In the seventeenth century the large rewards obtained by many successful practitioners made dress, manner and reputation the chief ends of the medical man.

We may amuse ourselves reflecting over the woeful deficiencies of former generations, but it is not difficult to detect traces of these same faults in present-day institutions, and the fact that they are mostly due to neglect of a sound principle of utility. It is a widespread doctrine that science in a medical school should be pursued for science' sake, and hence we see the fundamental sciences taught mostly by men without medical training or interests, who often deliberately neglect the medical aspects of their subject. Most of these men realize that they would be better and happier in their work if they had had a medical education. Who can understand the liver if he has not seen it in acute yellow atrophy? Who can know the cell if he has not followed its cancerous riot? There was a time when it was difficult to secure physicians competent to teach the preclinical medical sciences, but that time should have passed.

The great expansion of experimental medicine often leading to the pursuit of random topics and questions distantly related to medicine, may be a necessary phase of the growth of the scientific spirit, but it distracts attention and resources from the real, urgent and often solvable problems of medicine.

The close affiliation or union of general and special hospitals with university medical schools and the introduction of the university spirit into the life of hospitals is the most significant advance made in medical organization in this century. It mitigates the rigid scientific spirit, directs it to the practical problems presented by sick patients, and encourages the study of these problems under the best conditions. There is good reason to believe that the progress of clinical medicine in the immediate future will depend largely on the more intelligent interpretation and use of data secured in the laboratory. The laboratory trained clinician has many advantages, but it is difficult to shine both at the bedside and in the laboratory, and many fear that pure clinical research and the art of medicine are unwisely neglected by the praiseworthy attempt to cover both fields. Unless a safe principle of utility is adopted, the laboratory clinician may become absorbed in the rediscovery of old facts by new methods and the easy pursuit of interesting but secondary phenomena of disease. The universe is full of interesting facts, as numerous as sand grains on the ocean beach, but not all are important, and the wise investigator and physician, imbued with a sound university spirit, will choose carefully and avoid being lost in the sea of knowledge. All these tendencies and many others form the modern scholasticism. We have seen its deadening effect on the medicine of the past, and we should defend against it by intelligent adherence to the principle of utility. "All knowledge attains its ethical value and its human significance only by the human sense with which it is employed" (Nothnagel).

Modern university medical schools, especially the American, are singularly slow to realize the enormous growth of many medical specialties, the opportunities for service, the dependence of progress on experience and the necessity of providing adequate facilities for such normal and inevitable growth. The institute idea seems to be new to many who find themselves directing university development. Yet, institutes of pharmacology began to appear in the seventeenth century, and institutes have figured prominently in the growth of many branches of medicine ever since. They are particularly necessary at the present stage of medical progress, especially as viewed from the utilitarian standard.

Yet two New York schools have recently absorbed famous institutes of obstetrics, founded by men of vision, with long and excellent records in education and service. They are now merged with gynecology, in accordance with a policy recently adopted by many schools. Only experience can determine whether obstetrics will profit by these changes and whether these institutions will thereby be able to improve on their past records. In the meantime many regret the passing of these old-time ornaments of New York medicine, and they hope that New York has not lost the opportunity of duplicating some of the famous maternity hospitals of the world.

Not one of the great university medical schools has taken a vigorous initiative in the modern institute movement for the control of tuberculosis or cancer, by the creation of institutes for service and research in these paramount interests of humanity. All the medical schools do a little orthopedic surgery, but the progress of orthopedics was long since consigned to special hospitals and institutes devoted exclusively to this field. The same situation holds in pediatrics and in contagious diseases.

Dental institutes are making progress slowly but surely, but legal medicine knocks in vain at the university back door. On the other hand, the McCormick Institute for Infectious Diseases at Chicago, the School of Hygiene at Hopkins, the Institute of Human Relations at Yale and the department of psychiatry of the New York Hospital-Cornell Association are fine expressions of the institute idea and ominous signs of the size to which the arms of university medicine must grow if it is to keep pace with progress. Yet, in general, it must be admitted that the growth of modern medicine in recognition of the principle of utility, the demand for service and the dependence of progress on service have outstripped the vision of the organizers of university medical schools. Unless these demands are met, the real progress of medicine will pass out of the hands of the universities, as it has already partly done in some fields. These schools will then be free to devote their vast resources to the pursuit of medical science as a branch of biology and to experiments in medical education. This is the essence of scholasticism.

The university medical school has never known quite how to handle the question of the extramural activities of its scholars. In general it discountenances such activities without much concern about their great educational value. It leaves the busy world to take care of itself. It feels little responsibility for the way medicine is practised.

Into this breach medical men with the university spirit have thrown themselves with energy and intelligence. The results have been excellent because they adopted the principle of utility. Organizations have been formed devoted to the advance and dissemination of the higher branches of medical knowledge, to postgraduate instruction, to the collection of great libraries, to the organization and elevation of hospitals, to the interests of the nursing profession, to problems of public hygiene, to the policies of governments in medical affairs, and in fact to all the practical relations of medicine in social life. These bodies have long been a powerful influence for good in their communities, and they have generally been animated by a fine conception of the university spirit. Such a body is the Royal College of Physicians of England, originated in 1518 and gradually reaching its present form and influence after centuries of service in the field of organized medicine. The Royal Society of London was founded in 1660. Similar societies followed in Naples, Dublin, Berlin and Paris, all devoted to the advancement of science and its practical applications. To-day every great city supports one or more societies engaged in the extension of university medicine in its community.

There was thus ancient precedent for the formation of the New York Academy of Medicine in 1847, but there are few if any examples of the remarkable growth of its activities and of the influence it exerts in its community. Its great library elevates the standard of medical knowledge in this and other neighboring cities. A long list of affiliated societies prosper under its patronage. With rare vision, it has discerned and embraced many opportunities to advance and extend the application of medical knowledge. It is concerned with the standards of medical practice and morals, censors medical news, protects the public against errors and abuses, cooperates with medical schools, influences legislation and, adopting the principle of utility, interests itself in all that interests medicine and the public. It is one of the most efficient of all agencies in extending the influence of medicine into a broad and extremely practical field.

V

And now, what does this review of the history and present position of the university reveal? Does it not show that the university has been at all possible times the mainspring of intellectual and scientific progress? It may have declined with the decay of nations, but it has always taken the first step toward the revival of learning and the advance of knowledge. Hence it has survived religions, is more powerful than government and has a better record than the church. In the university medicine has always occupied a commanding position because it deals with a primal necessity, self-preservation. At times medicine has been almost the sole source of inspiration toward learning and intellectual effort. Medicine directed by the university idea has accomplished great things in the control of disease and the revelation of man's physical nature, but its main task still lies before it. We may not wisely conceive of a world without physical evil. It would hardly be human. There is no such danger. Yet there are voices acclaiming the arrival of the day when medicine, having virtually conquered the old diseases, may now pass on to birth control, eugenics and the superman—dreams, possible to him who ignores the stern realities of the sick room and the dead house. Preventive medicine has done much, but the era of clinical efficiency in curative medicine is still to dawn.

The world looks hopefully to the university and its medical school and to educated physicians to go forward with the task of controlling disease and carry it as far as may be. We shall therefore jealously guard the best traditions of the university ideal. We shall see to it that attested medical knowledge is carried into every human activity and relation where it may be of service in the control of disease and the elevation of the standard of intelligence, and by cooperative intellectual and moral endeavor, we hope to justify mankind's great adventure in altruistic effort, the university.

ROOSEVELT, THE NATURALIST[1]

By Dr. C. HART MERRIAM

WASHINGTON, D. C.

When I was a boy there was a branch of knowledge called natural history. And there were men called naturalists—men whose main object in life was the study of our native animals. Of them Spencer F. Baird, for many years secretary of the Smithsonian Institution, was by far the most eminent, most influential and most helpful.

But Baird was by no means the first to interest himself in natural history. Three hundred years before his time some of the Pilgrims to New England and Virginia gave entertaining accounts of the animals of their new home, and a century or more afterward several Englishmen who had lived many years in America, notably Mark Catesby, Alexander Wilson and Thomas Nuttall, gave the world valuable books on the fauna and flora of our Eastern and Southern States.

Still more important from the technical standpoint were European naturalists, who from the time of Linnaeus to that of Cuvier, published technical works on the animals of the world. These contained descriptions of American animals based on specimens and information from "overseas."[2]

It was not long, however, before American-born men of letters began to interest themselves in the fauna of our country. Outstanding among these were the eminent ornithologists, John James Audubon and his co-worker Dr. John Bachman, whose monumental works on birds and mammals with their splendid colored plates have never been surpassed; and Dr. John J. Godman, whose "American Natural History" was in such demand that several editions were printed. Others worthy of mention were Dr. Benjamin Smith Barton, Governor DeWitt C. Clinton, James E. DeKay, Dr. Richard Harlan and Edward Hitchcock.

The distinguished Swiss naturalist, Louis Agassiz, who came to America in 1846, was made professor of zoology at Harvard in 1848. His stimulating influence can hardly be overestimated. Among his many students at Harvard and Penikese were Newberry, Verrill, Morse, Packard, Scudder, Alexander Agassiz, Hyatt, Shaler, Wilder, Garman, Allen, Brooks, Walcott, Fewkes and Jordan—men whose names stand as monuments along the highway to knowledge of animal life.

Another naturalist of the period was Sanborn Tenney, professor of zoology at both Vassar and Williams Colleges. Tenney, though not a technical worker, published a "Manual of Zoology," which, in spite of its shortcomings and crude illustrations, was widely used and proved a great help to hundreds of young men and women. To many of us who lived in the back country it was a priceless boon. I confess that in my younger days I prized it more highly than any other book, for it stimulated my interest and enabled me to identify the mammals, birds and reptiles of New York State. I was not then familiar with DeKay's volumes on the natural history of New York.

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[1] Address made on the occasion of the presentation of the Roosevelt Distinguished Service Medal in Natural History to Dr. C. Hart Merriam. The presentation address by the secretary, Hermann Hagedorn, was as follows: "For distinguished service in the field of natural history, Mr. President, I have the honor to present the name of one who for over sixty years has studied the wild life of earth and sea and air. Founder and for a quarter century director of the United States Biological Survey; the leader, among American scientists, in the field of mammalogy; a profound scholar not only in his own domain but in the fields of plant life and ornithology, of faunal and physical geography, and of the language, customs and racial origins of the Indians of the Pacific Coast; a tireless investigator and expounder, who, in the laboratory, has distilled the knowledge garnered under the open sky.

[2] After Linnaeus, the most notable of these were Erxleben, Gmelin, Pennant, Pallas and F. Cuvier. Their works are the foundations of our present-day systematic zoology.

Returning to Baird: Baird's influence with Congress and with the people was far greater than that of any other man. He invigorated the Smithsonian, enhanced its reputation and broadened its field of usefulness. He created the National Museum and the U. S. Fish Commission. He fostered the government's transcontinental expeditions known as the Pacific Railroad Surveys and named surgeon-naturalists to accompany them for the purpose of collecting animals and plants in unexplored parts of the little known West.

He was the kindly, helpful friend of many a young naturalist—among whom Theodore Roosevelt and I were proud to have been numbered. It was Baird who in 1872, when I was a lad of sixteen, secured my appointment as naturalist of the Hayden Survey of the Territories; and, three years later, as assistant on the Fish Commission.

Baird was an indefatigable worker. He felt that the time had arrived for an overhauling and rewriting of the technical works on the land faunas of America and promptly set about the task. Of all the naturalists of our generation he made the most important and most lasting contributions to knowledge. The period of his activities has been named the Bairdian Period.

Among his disciples who attained eminence in the field of natural history were Captain Chas. E. Bendire, E. D. Cope, Elliot Coues, W. H. Dall, B. W. Evermann, Charles H. Gilbert, Theodore Gill, G. Brown Goode, Henry W. Henshaw, F. A. Lucas, O. C. Marsh, E. W. Nelson, Mary J. Rathbun, Robert Ridgway, L. Stejneger.

Baird died in 1887. At that time interest in natural history was at its heydey.

But it was not to last, for soon came the great development of the microscope, permitting intensive studies of minute organisms and revealing "worlds unknown." It took the colleges by storm. In a surprisingly brief period microscopes stood in rows on the laboratory tables, and the things seen through their lenses came to be called "Biology." The more obvious forms of life were no longer of interest.

Then by means of lectures and laboratory instruction many young men and women interested in outdoor natural history were led to abandon their first interest and substitute the revelations of the microscope and section cutter. Many a promising naturalist was thus diverted from his intended career. Some accepted the substitute; others, grievously disappointed, abandoned scientific work.

Years of sadness followed—long years in which the study of general natural history not only languished; it all but expired. Our instructors in their enthusiasm over the all-important revelations of the microscope seemed to overlook the fact that this instrument is not the only road to knowledge—forgetting that it takes no account of the higher forms of life and fails utterly to explain the interrelations of life and environment.

An ominous cloud had overspread the broad field of natural history, blinding teachers to the dependence of wild life on the nature of the home; blinding them to the obvious groupings of unrelated animals in certain localities; and blinding them further to the modifications or splittings of species as brought about by factors of environment and distribution.

Even museum studies of skins and skulls came to be frowned upon as trivial.

For a while it seemed that faunal and systematic natural history were destined to be swept off the face of the earth. But the influence and teachings of the elder Agassiz in studies of marine life and of Spencer Baird and his followers in studies of land animals, were not wholly lost. Some of the disciples of these great men held on, and now and then a sporadic naturalist appeared—a sort of ancestral throwback who, following the trails of Baird and Allen, kept the breed alive until the United States Biological Survey, and later the Museum of Comparative Zoology of the University of California, began the training of a new group of faunal naturalists. These naturalists were taught to broaden their zoological horizon by including the study of conspicuous types of plant life—thereby illuminating their comprehension of nature. Their knowledge of the environmental factors that control the distribution of animals and plants has contributed in no small degree to the present-day understanding of our fauna and flora.

To-day these younger men are leaders of the minority that has striven to stem the overwhelming tide of collegiate biology which for so many years threatened to engulf and exterminate the race of field and systematic naturalists.

Theodore Roosevelt had the instincts, the powers of observation and the vision of a faunal naturalist. Half a century ago he wrote me, confirming my account of the food habits of the short-tailed shrew and giving his personal observations on this little animal. At that time he had prepared numerous specimens of mammals and birds and had already begun a museum.

While his strenuous life as President interrupted, it never dimmed his interest and enthusiasm for natural history. Once during the spring migration of birds he phoned me to breakfast with him at the White House to make sure of a species of warbler then visiting the tall elms south of the mansion. His identification of the little birds as blackpoll warblers proved correct.

Another time, when that remarkable man, Ambassador Bryce, had expressed a desire to see in life our American kingfisher and the red-eyed pipilo or towhee, the President led us to places well known to him in the forest north of the city, where both birds were seen and heard—much to the ambassador's satisfaction.

In later years, when living in Washington, he joined Vernon Bailey and me in a twilight bicycle trip up Rock Creek to see a beaver (presumably an escape from the Zoo) which had temporarily established itself on that stream. He was "delighted" to see the beaver cut a willow and swim with it to a floating log, where he sat up and ate the bark.

Few people are aware of Roosevelt's knowledge of mammals and their skulls. One evening at my house (where I then had in the neighborhood of five thousand skulls of North American mammals) he astonished every one—including several eminent naturalists—by picking up skull after skull and mentioning the scientific name of the genus to which each belonged.

He was deeply impressed by the gigantic size of the great Kadiak bear as contrasted with the Rocky Mountain grizzlies, and several times brought friends to see for themselves the enormous difference between the skull of an old male Idaho grizzly and that of one of these giant Kadiaks—the two standing side by side on my desk.

On one occasion, before a meeting of the Biological Society of Washington, he crossed swords with me in regard to the validity of several species of coyote as shown by their skulls.

Roosevelt's publications on hunting and on the game animals of the Plains and Rocky Mountains,[3] his daring exploration into unknown parts of South America,[4] his excellent accounts of African game animals,[5] his "Biological Analogies in History," "A Booklover's Holiday in the Open," and his critical work on "Revealing and Concealing Coloration in Birds and Mammals" rank among the more important of his contributions to the knowledge of nature.

He had great respect for genuine hunters—the kind who endure hardship, exhibit prowess and tell the truth—such men as Selous, Warburton Pike, George Bird Grinnell and Charles Sheldon. Early in his career in the White House he asked to be notified when out-of-town hunters came to the city. So when the Canadian hunter and sub-arctic explorer Warburton Pike had arrived, Sheldon and I were requested to bring him to dine at the White House. The time happened to be a particularly busy one politically, and we were warned that the President must excuse himself directly after dinner. But instead, he took us upstairs and kept us in his den till midnight. He was several times interrupted by messengers, but declined to see them. Finally his son-in-law (Nicholas Longworth) came with an important telegram. Roosevelt waved him away with the remark that he was not to be interrupted—that for this one night he felt entitled to enjoy himself.

Theodore Roosevelt lived during the period of ultra-microscopic specialization in the study of animate nature—the sad period in which the good old term "natural history" fell into disuse, actually disappearing from text-books and college curricula; nevertheless he was not misled.

The keenness of his observation coupled with his intimate first-hand knowledge of nature enabled him to recognize the necessity for field work and convinced him of the absolute need of museum specimens for exact studies of animals and plants.

He appreciated the work of the Biological Survey and aided it with his personal influence, even incorporating a paragraph about it in at least one of his messages to Congress.

If his major interests had not been diverted into the time-consuming field of politics he would have been one of America's foremost naturalists.

In conclusion, Mr. President, may I express my deep personal gratification that the medal you have seen fit to award me is an acknowledgment and a tribute both to the science of natural history and to the memory of the great man whose name it bears.

OBITUARY

ROBERT DeCOURCY WARD

ROBERT DECOURCY WARD, professor of climatology at Harvard University, died suddenly at Cambridge, Massachusetts, on November 12, 1931. He was born in Boston on November 29, 1867, but at the age of six months was taken to Dresden, Germany, where he remained for four years. He then was one year in Switzerland, one in England, and returned to Boston in 1874. In 1879 he again went to Dresden for two years. On returning to Boston he entered Noble and Greenough's School (later Noble's School), from which he graduated in 1885. In 1889 he graduated at Harvard, *summa cum laude*. The following year was spent in Europe. In September of 1890 he returned to Harvard as assistant to Professor W. M. Davis in physical geography and meteorology. In 1893 he was made assistant in meteorology; in 1895 instructor in meteorology; in 1896 instructor in climatology; in 1900 assistant professor of climatology; in 1910 professor of climatology. Such was the brilliant teaching career of the first professor of climatology in the United States, a career begun under the stimulus and encouragement of Professor Davis, for whom his affection and admiration never waned, nor had cause to.

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[3] "The Deer Family"; "American Big Game Hunting"; "Hunting the Grizzly"; "Hunting Trips on the Prairie"; "Hunting Trips of a Ranchman"; "The Wilderness Hunter"; "Ranch Life and the Hunting Trail"; "Hunting in the Cattle Country."

[4] "Through the Brazilian Wilderness."

[5] "African Game Trails"; "Life Histories of African Game Animals" (by Roosevelt and Heller).

Professor Ward's first contribution of importance to meteorology was his study, during the senior year of his undergraduate course, of the sea breeze in New England. While in the Graduate School, where he took the A.M. degree in 1893, he completed an extensive study of the thunderstorms of New England. From 1892 to 1896 he edited the *American Meteorological Journal*, an excellent magazine that suspended publication in this latter year only because its field had become fully occupied by the official *Monthly Weather Review*. He did not take the Ph.D degree, because no instruction adequate therefor was then available in meteorology and climatology, his chosen subjects.

Since he was founding a new school, the school of climatology, it was necessary for him to do a prodigious amount of work in assembling and putting in logical order and making clear all the best work on that subject by others. As he said, it was his chief job to make simple what others had made involved. So devoted was he to his teaching that he continually, year after year, revised his lectures so as to make them as complete and informative as possible. This labor for his classes left relatively little time for writing. Nevertheless, there are far over 300 titles to his credit, exclusive of numerous notes and many reviews. There are also books, four finished, including a translation of the first volume, general climatology, of Hann's "Handbuch der Klimatologie," and books just begun. His best known work, "The Climates of the United States," represents a large amount of personal investigation and also a great deal of guided research on the part of his students. It is an inspiration to the student and a delight to the general reader.

Professor Ward believed that best teaching is based on personal experience. He therefore sought to know the climates which he had most need to discuss. This quest took him to all parts of the United States, the West Indies, South America (three trips), Europe, most portions of the Atlantic Oceaan, and around the world. He planned to write a "Guide Book to the World's Weather and Climate," based largely on his own observations.

Though teaching was his passion, he also had exceptional executive abilities that led to his being chairman (1928–1930) of the Harvard board of freshman advisers; chairman for many years of the executive committee of the Immigration Restriction League, which he helped to found in 1894, and later its president. In 1917 he was president of the Association of American Geographers, and from 1920 to 1922 the efficient first president of the American Meteorological Society. He also was a fellow of the American Academy of Arts and Sciences, and a member of the American Philosophical Society, as well as also of a number of other learned organizations both in this country and abroad.

Despite his many duties and extensive careful writings Professor Ward still found time to be human and a delightful companion—rich in information and wisdom or sparkling in wit and humor as the occasion required.

W. J. HUMPHREYS

RECENT DEATHS

ANDREW ALEXANDER BLAIR, author of "The Chemical Analysis of Iron" and numerous papers on chemical analysis, died on January 25 in his eighty-fourth year. He was formerly chief chemist of the U. S. Geological Survey, and for the past fifty years senior partner of Booth, Garrett and Blair, analytical chemists, Philadelphia.

DR. JOHN BROWN FRANCIS HERRESHOFF, metallurgical chemist of New York City, died on January 30 at the age of eighty-one years.

ALEXANDER JAY WURTS, since 1905 professor of applied electricity in the Carnegie Institute of Technology, died on January 21 at the age of sixty-nine years.

THE death on January 30, at the age of sixty-eight years, is announced of James Hillhouse Fuertes, civil engineer, known for his work on sanitation and water supply. Mr. Fuertes was a son of the late Professor Estevan Fuertes, formerly head of the engineering department at Cornell University and the brother of the late Louis Agassiz Fuertes, naturalist and painter of bird life.

EUGENE C. GLOVER, of the Thorndike Memorial Laboratory of the Boston City Hospital, died on January 22 at the age of twenty-nine years. Dr. Glover was accidentally poisoned by cyanide of potassium used in his study of cancer.

William L. Patterson, director of the technical bureau of the Bausch and Lomb Optical Company, a designer of microscopic and projection apparatus, died suddenly on February 5 at the age of fifty-eight years.

Herbert Clarke Arms, for twenty-eight years associated with the Central Scientific Company, of which he was vice-president, died on January 22 at the age of sixty years. Mr. Arms had been president of the Chicago Drug and Chemical Association.

Sir Alfred Yarrow, the English marine engineer and shipbuilder, died on January 24. He was ninety years old.

The death is announced of Dr. Wilhelm Nienburg, professor of botany at Kiel.

A correspondent writes: "The announcement has been received of the death on December 27 of Professor Dr. Heinrich Wieleitner, Oberstudiendirektor in the new Realgymnasium and honorary professor at the University of Munich. Professor Wieleitner was well known to all students in the history of mathematics. He was a serious scholar and a clear and accurate writer. His loss will be felt in this country as well as in Munich, where he worked for so many years."

SCIENTIFIC EVENTS

THE BANTING RESEARCH FOUNDATION

In 1925, Sir William Mulock, Chief Justice of the Province of Ontario and now Chancellor of the University of Toronto, and the Honorable and Rev. Canon H. J. Cody, with a small group of associates, decided to establish a foundation in honor of the discovery of insulin by Dr. F. G. Banting. The campaign for funds met with gratifying response and subscriptions amounting to over half a million dollars were secured. The whole amount did not become available for a period of about four years, and the capital sum of the foundation has now grown to about $700,000.

Under the charter secured for the foundation, a part of the income is devoted to aiding in the maintenance of the Banting and Best Chair of Medical Research in the University of Toronto, while the remainder is disbursed in grants to workers in Canada who propose definite problems of medical research. The foundation has, during the past two years when it has been in receipt of its full income, aided in the researches of thirty-eight workers; and during the past year, in spite of the exercise of great care in the selection of the problems to be supported, the trustees have expended practically the whole of their annual income.

There is little doubt that this foundation has contributed not a little to the development of medical research, especially in those medical schools in Canada which have the smallest incomes. The wide-spread character of its work is best evidenced by the fact that during the past year, the following researches were supported by the foundation:

Dr. A. C. Abbott, Winnipeg, Thyroid Gland, Bone Formation; Dr. R. H. Fraser, Winnipeg, Oriel's Test; Dr. J. W. Gilchrist, University of Western Ontario, Puerperal Sepsis; Dr. Rudolf Gottlieb, McGill University, The Reticulo-Endothelial System; Dr. A. M. Davidson, Winnipeg, Fungous Dermatoses; Professor F. D. White, University of Manitoba, The Bilirubin Content of the Serum; Dr. John McEachren, University of Manitoba, Cholesterol Metabolism; Dr. F. Hartley Smith, St. Boniface Hospital, The Blood in Pregnancy; Mr. G. T. Evans, McGill University, Glycogen in Cardiac Metabolism; Miss E. R. Grant, McGill University, Glycogen Metabolism; Mr. J. M. Hershey, University of Toronto, Lecithin in Metabolism; Dr. C. M. Jephcott, University of Toronto, The Quantitative Extraction of Insulin; Mr. P. G. Mar, University of Manitoba, Cutis Laxa; Dr. H. A. Cates, University of Toronto, Anthropological Study of Delivery; Professor V. J. Harding, University of Toronto, Normal Urinary Sugar; Mr. H. C. Graham, Dalhousie University, Uric Acid; Dr. M. M. Cantor, University of Alberta, Addison's Disease; Dr. R. Pearse, University of Toronto, The Ureter in Pregnancy; Miss Ruth Dow, McGill University, The Cortical Auditory Area; Mr. F. L. Horsfall, Jr., McGill University, Lactic Acid; Dr. Helen L. Vanderveer, University of Toronto, Arteriosclerosis; Mr. Samuel Weinstein, University of Saskatchewan, Oxidation Products of Adrenaline; Dr. R. A. Moreash, Dalhousie University, Toxicity of Various Arsenicals; Dr. D. R. Mitchell, University of Toronto, The Treatment of Cystitis; Dr. Maurice Brodie, McGill University, Poliomyelitis; Mr. R. B. Kerr, University of Toronto, Experimental Peritonitis; Mr. L. R. LeFave, Queen's University, Non-lactose Fermenting Organisms.

The Board of Trustees of the Banting Research Foundation, of which Sir Robert Falconer is chairman and the two above-mentioned gentlemen are members, hope that the capital sum, the interest of which is at their disposal, will grow, as the work of the past two years has made it evident that a need exists for such a research fund as this in Canada.

V. E. Henderson
D. T. Fraser
Honorary Secretaries

EXHIBITION OF THE ROYAL METEOROLOGICAL SOCIETY

AN exhibition arranged by the Royal Meteorological Society in the Science Museum, South Kensington, was opened on January 11 by Sir Napier Shaw, formerly director of the Meteorological Office, who spoke on the progress of meteorology during the last twenty years.

According to the London *Times*, the exhibition, which was on the second floor of the museum, was especially remarkable for the display of photographs of cloud-formations taken by members of the society. While these were chosen for the scientific information which they contain, many of the effects shown being rarely observed, the technical and esthetic quality of the prints is equally noteworthy. Among the observers whose work was illustrated are Mr. E. G. Bilham, Captain C. J. P. Cave, Mr. G. A. Clarke, Mr. F. W. Baker and Mr. A. V. V. Clayden. Sir Gilbert Walker showed photographs of natural cloud-formations, with parallel photographs of the same phenomena illustrated on a smaller scale in liquids such as evaporating spirit and oil. Diagrams of typical cloud-formations were also illustrated from the new International Cloud Atlas.

A display of historical instruments was lent by the Meteorological Office, while modern instruments were illustrated through a trade exhibit by British firms and by several official exhibits on a large scale. One stand contained the constituents of a typical Air Ministry meteorological station, including a Stevenson screen with its maximum and minimum and dry and wet-bulb thermometers, a Fortin barometer with magnifying eyepieces, an Owens air-filter for measuring impurities, a stream-line wind-vane, and a range-gauge designed for mountain use, with special precautions against bursting under frost. Opposite this is to be seen a gigantic anemometer of the type used by the Air Ministry to measure the velocity of air-currents, but with its normal height of 40 ft. or 50 ft. reduced to 12 ft. to get it in the gallery.

The developments of the Campbell-Stokes sunshine recorder during the half century since its invention was also demonstrated through comparative exhibits, while lightning conductors were shown in a special case, the examples including one installed by Benjamin Franklin on St. Paul's. There were also screens displaying the changes in the distribution of rainfall averages over the British Isles by week, month, year and decade. The heaviness of the annual rainfall appears to vary in a roughly triennial cycle, but it is seen that the remarkable rainfall of 1872 has not since been paralleled.

Public lectures on meteorology were given at the museum during the exhibition. The first, by Mr. D. Brunt, described the part played by meteorology in history. Dr. G. C. Simpson, director of the Meteorological Office, explained modern weather forecasting, and Captain C. J. P. Cave and Colonel Sir Henry Lyons (director of the Science Museum), spoke respectively on clouds and on historic meteorological instruments. The exhibition remained open for one month.

THE WESTCHESTER INSTITUTE OF SCIENCES

THE committee of five, appointed at the first meeting of the Westchester Institute of Sciences on December 16, last, met on January 7 to formulate a temporary organization for the institute. The meeting was held at the Boyce Thompson Institute for Plant Research in Yonkers at the invitation of Dr. William Crocker, its director.

The committee consisted of Dr. Crocker, Professor Roy J. Colony, of Columbia University, Mr. George P. Engelhardt, entomologist and museum expert, Mr. Albert Brand, ornithologist, and Mrs. Mary Welleck Garretson, formerly supervisor of the Nature Lore Workshop, as chairman.

As a result of this meeting, it was decided to form a temporary organization until fall, with temporary officers in charge. The names of those nominated are as follows:

Chairman: Dr. H. H. Sheldon, physicist, or Dr. Forman T. MacLean, botanist.

Vice-chairmen or Advisers: Dr. William Crocker, botanist, and Professor Roy J. Colony, geologist.

Secretary: Mrs. Mary Welleck Garretson, geologist.

There are to be five program meetings on the evenings of the third Thursdays of each month beginning in January. Three of the programs are planned and will be held in various parts of the county rather than in one place.

The first meeting will be in the Eastview Avenue Junior High School, White Plains, and after a short business session and the admission of members, there will be a first showing of the motion pictures of the Graves-Thorne expedition to Alaska and northern Siberia for the Field Museum of Chicago. The talk with the pictures will be given by Mr. John Jonas, explorer-naturalist of the expedition.

The second meeting, by the kindness of Dr. Crocker, will be held at the Boyce Thompson Institute and will consist of a series of short talks illustrated by pictures or demonstrations by the research scientists of the institution. It will be a meeting of especial interest to science teachers.

The third meeting, in March, will have for its program an illustrated talk on "The Geology of Westchester" by Professor R. J. Colony, of Columbia University.

Any one interested in becoming a member of the Westchester Institute of Sciences should apply to the secretary, Westchester Institute of Sciences, of the Westchester County Conservation Association, 8 Martine Avenue, White Plains. Scientific men, science teachers, nature science workers and all persons interested in science or nature are invited to attend the meetings and to join the institute. Nominal dues of one dollar for this season cover membership.

THE FIELD MUSEUM OF NATURAL HISTORY

Final statistics on the activities of the Field Museum in 1931 indicate that more than 2,240,000 persons benefited directly from the work of the institution during the year. This figure includes the number of visitors to the museum—1,515,540, a total which exceeds by far any previous year's record in the history of the institution—and also more than 727,000 children reached by extra-mural activities of the museum.

The year was the fifth in which the attendance exceeded one million. The increase over the 1930 total of 1,332,799 visitors is 182,741 or approximately 13.5 per cent., and compares with a gain of 164,369 made in 1930 over 1929.

While the total attendance increased so notably, all the gain was in free admissions, the paid admissions decreasing from 160,924 in 1930 to 126,209 in 1931, a development which undoubtedly may be largely attributed to the economic conditions which have prevailed during the past year. The attendance on free days plus the free admissions on pay days granted to members, children, teachers, students, etc., amounted to 1,389,331, or considerably more than the total of free and paid admissions together in 1930. It is estimated that more than one third of the total number of visitors were children.

The additional 727,000 children coming under the influence of the museum's educational work are accounted for as follows: The James Nelson and Anna Louise Raymond Foundation, in addition to providing programs at the museum itself for thousands of children, reached 227,351 school pupils through lecturers sent out to address them in their classrooms and assembly halls. (The total number reached by all Raymond Foundation activities, including both those inside and outside the museum was 303,693.) In addition, approximately 500,000 children were reached over and over again during the year by means of traveling exhibition cases displayed in all the public and many other schools (with changes of subjects every two weeks) through the Department of the N. W. Harris Public School Extension.

Less directly the museum reached probably millions of other persons by such various means as the circulation of its publications, reports in the newspapers, radio broadcasting, motion picture news reels, etc.

The highest attendance for any single day during 1931 was on May 21, when 51,917 visitors were received in the building. This was exceeded on only two previous days in the museum's history—June 20, 1926, with 54,024 visitors, and May 24, 1929, with 59,843 visitors.

The total attendance for the first ten years of occupancy of the present building (May 2, 1921, to May 1, 1931) was 8,597,409, as compared with a total of 5,839,579 for the more than twenty-five years during which the museum was located in its first building in Jackson Park.

At the annual meeting of the Board of Trustees of the museum, held on January 18, Messrs. John P. Wilson and Sewell L. Avery were elected as trustees to fill the vacancies left on the board by the death of R. T. Crane, Jr., and the resignation of William Wrigley, Jr.

For the twenty-fourth time Mr. Stanley Field was reelected President of the Museum. Mr. Field has held this office since January, 1909. All the other officers who served during 1931 were re-elected for 1932.

THE ENGINEERING SOCIETIES LIBRARY

The year 1931 was the most active in the history of the Engineering Societies Library, according to the annual report of the director, Mr. Harrison W. Craver. Surpassing all previous records, the library responded to 42,659 requests for technical information, an increase of 2,577 over 1930. Its service extended to practically every country in the world.

A total of 27,943 visitors, 10 per cent. more than in 1930, taxed the seating capacity of the library, indicating that the time is approaching when additional space will be needed. Valuable book collections were acquired, and more than $50,000 was expended during the year.

The book collection has been inventoried and only 1,267 books and pamphlets could not be found, a remarkably low number to have been lost in fifteen years, Mr. Craver says. While such losses are extremely annoying, they are inevitable when readers have free access to books. Fortunately, none of the missing works is of great value and almost all can be readily replaced. The general condition of the library is reported to be excellent. Through the Professional Engineers Committee on Unemployment, it has been possible to accomplish a large amount of work for which the staff could not spare time from regular duties.

At the beginning of the year, the permanent collection contained 124,539 books, 4,535 pamphlets, 6,290 maps and 4,552 searches, a total of 139,916. During the year 3,410 books, 4,145 pamphlets, 208 maps and 94 searches were added, and 3,680 pamphlets withdrawn. On December 31, 1931, the collection numbered 127,949 books, 5,000 pamphlets, 6,498 maps and 4,646 searches, a total of 144,093.

The loan collection contained 1,215 books at the beginning of the year Additions were made as they were needed. Thirteen volumes were sold, and some no longer in demand were withdrawn. The duplicate collection now contains about 9,000 volumes. During the year, 3,681 volumes were added, 1,800 were sold and 1,721 presented to other libraries.

Books, pamphlets and maps received during the year numbered 12,134. Of these, 9,834 were gifts, including 237 volumes of the minutes of *Proceedings* of the Institute of Civil Engineers, from the American Society of Civil Engineers; *Proceedings* of the World Engineering Congress, Tokyo, from Mr. George D. Barron; a collection of pamphlets on petroleum, from Mr. F. G. Clapp; a collection of standard works on engineering, from the *Engineering News-Record;* sets of the *Electrical World* and *Power,* from Mr. Andrew Kidd; 243 volumes of the *Annales des Ponts et Chaussees,* from Mr. Ralph Modjeski. Also, 130 volumes and pamphlets on railroad and public works, from Mr. F. A. Molitor; a collection of treatises upon automotive engineering, from the Society of Automobile Engineers; a collection of Russian periodicals, from the Russian Association of Engineers.

The books acquired included many already in the library. After examination, 7,857 were added to the permanent collection, 150 to the loan collection, and 3,681 were placed in the duplicate collection.

Two hundred and eighty-six maps, 248 searches and 3,943 volumes, representing 5,051 titles, were catalogued. The catalogued material now comprises 6,321 maps, 3,872 searches and 127,949 volumes, or 138,142 items in all. The number of titles or separate works, as distinguished from volumes, is 69,400. The index to the catalogue contains 37,591 subjects and the catalogue contains 450,939 cards.

The periodical index now contains 27,000 references to important articles. More than 13,000 entries were added in 1931.

One hundred and seventeen searches and 242 translations were made during the year. The number of photoprints was 41,614 for 4,585 persons. Inquiries from 5,946 members were answered by telephone and 3,620 others were assisted by mail.

SCIENTIFIC NOTES AND NEWS

DR. W. C. MENDENHALL, acting director of the U. S. Geological Survey, after the retirement of Dr. George Otis Smith to become chairman of the Federal Power Commission, has been appointed by President Hoover director of the survey.

DR. W. W. KEEN, emeritus professor of surgery in the Jefferson Medical College, Philadelphia, president of the American Philosophical Society from 1908 to 1917, celebrated his ninety-fifth birthday on January 19.

THE eleventh award of the Faraday Medal has been made to Sir Oliver Lodge by the British Institution of Electrical Engineers. The medal is awarded not more than once a year, irrespective of nationality, for conspicuous service rendered to the advancement of electrical science.

THE Melchett Medal of the British Institute of Fuel for 1931 was presented to Professor William A. Bone, of the Imperial College of Science and Technology, South Kensington, by the president, Sir Hugo Hirst, at the Institution of Electrical Engineers, on February 1. After the presentation Professor Bone delivered the Melchett Lecture, his subject being "A Century of Fuel Economy." Immediately afterwards Professor Bone was the guest of honor at a dinner given by the institute.

DR. ALEXANDER PETRUNKEVITCH, professor of zoology at Yale University, has been elected an honorary member of the Entomological Society of Belgium.

DR. BERTHOLD LAUFER, curator of anthropology at the Field Museum of Natural History, was elected president of the History of Science Society for the year 1932 at the meeting held in Minneapolis on December 29.

MR. HARRY A. KIDDER, superintendent of motive power of the Interborough Rapid Transit Company, has been elected president for 1932 of the United Engineering Trustees, joint agency of the four Founder Engineering Societies.

DR. B. S. PICKETT, head of the horticultural department of the Iowa State College, was elected president of the American Pomological Society at the recent meeting in Columbus, Ohio, on February 3.

DR. JAMES S. STEVENS, for forty-one years professor of physics at the University of Maine and for thirty-seven years dean of the College of Arts and Sciences, has retired from active service.

DR. IRVING W. FAY, for thirty-five years professor of chemistry at the Polytechnic Institute of Brooklyn, will become professor emeritus on September 1. Professor Fay has been invited by the corporation of the institute to assume charge of the chemical museum and collections, and at their request he will spend a considerable part of the year in Europe visiting museums and collections in foreign universities.

MR. RALPH HOWARD FOWLER, fellow of Trinity College, Cambridge, has been elected to the John Humphrey Plummer Professorship of Mathematical Physics in the university.

DR. WOLFGANG HEUBNER, professor of pharmacology at Heidelberg, has been called to Berlin.

DR. CHARLES H. RICHARDSON, professor of mineralogy and head of the department at Syracuse University for more than twenty-five years, has been appointed director of the Natural Science Museum. He has been relieved of a large part of his teaching so as to have time for research and museum work.

MR. C. F. HOBAN has been made director of the Pennsylvania State Museum at Harrisburg to succeed Mr. Frederic A. Godcharles.

MR. ERNEST G. HOLT has been appointed director of sanctuaries for the National Association of Audubon Societies.

DR. MARION R. HARRIS, recently of the University of Wisconsin, has been appointed associate plant pathologist in the State Department of Agriculture, Sacramento, California.

DR. J. G. DAVIDSON was elected vice-president of the Carbide and Carbon Chemicals Corporation at a meeting of the Board of Directors on January 14. Dr. Davidson, who has specialized in hydrocarbon chemistry, was fellow of the Mellon Institute until he entered in 1923 the employ of the donor of his fellowship, the Carbide and Carbon Chemicals Corporation.

PROFESSOR MADISON BENTLEY, of the department of psychology of Cornell University, has partial leave of absence to enable him to direct a study of the present state of the subject of mental disorders. The study is being made under the auspices of the National Research Council and is supported by a grant from the Carnegie Foundation.

DR. JAMES HENRY BREASTED, director of the Oriental Institute of the University of Chicago, left on February 4 to visit the Mayan excavations being conducted under the direction of Dr. Sylvanus Morley by the Carnegie Institution of Washington at Chichen Itza, Dzitas, Yucatan. Dr. Breasted expects to return to Chicago early in March.

MR. H. W. KRIEGER, curator of ethnology in the U. S. National Museum, has left for the West Indies, where he will investigate shell heaps and other aboriginal remains on the islands of San Salvador and Cuba.

DR. W. D. FUNKHOUSER, dean of the Graduate School and head of the department of zoology at the University of Kentucky, has completed arrangements for a collecting trip around the world in the search for insects of the family Membracidae, a group on which he has been working for many years.

DR. TERENCE T. QUIRKE, professor of geology at the University of Illinois, is spending his sabbatical year in Canada, where his address is in care of the Victoria Museum, Ottawa.

DR. LESTER W. SHARP, professor of botany at Cornell University, will be on sabbatical leave during the spring semester.

DR. WEBSTER G. SIMON, professor of mathematics at Western Reserve University, sailed for Europe on February 3. He will work at Cambridge and in German universities, attending in September the International Congress of Mathematicians.

DR. GUSTAV BUCKY, director of the x-ray department of the Virchow Hospital, Berlin, arrived in New York on January 31. He plans to make a study of the new developments in high-tension x-ray apparatus.

DR. J. J. GALLOWAY, professor of geology and paleontology at Indiana University, is giving a series of fourteen lectures on stratigraphy, paleontology and micropaleontology at Columbia University.

DR. A. C. IVY, head of the department of physiology and pharmacology at the School of Medicine, Northwestern University, will deliver the fifth Harvey Society Lecture at the New York Academy of Medicine, on February 18. His subject will be "Factors concerned in the Evacuation of the Gall Bladder."

DR. F. F. FISH, of the bureau of fisheries of the Department of Commerce, spoke on February 1 to the departments of medical zoology of the School of Hygiene and Public Health of the Johns Hopkins University on the fungus infection of fishes in the Gulf of Maine.

DR. O. E. WHITE, director of the Blandy Experimental Farm of the University of Virginia, gave on January 7 an address on "Genetics" before the Virginia Chapter of Sigma Xi.

PROFESSOR E. G. CONKLIN, head of the department of biology at Princeton University, recently delivered the annual Somerville Lecture at McGill University.

Dr. Willem de Sitter, of the University of Leiden, delivered on January 26 an address at Stanford University on "The Size of the Universe." The lecture was sponsored jointly by the university and the Society of Sigma Xi.

Professor Cecil H. Desch, of the University of Sheffield, England, lectured at the Carnegie Institute of Technology, Pittsburgh, on January 15 and 18 on "Mosaic Structures in Crystals" and "Age Hardening in Alloys." Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, lectured on January 21 and 22. He spoke on "Philosophic Concepts in Modern Physics" and on "Atomic Structure."

A series of Lowell lectures on "Radioactivity and Geology" by Professor Arthur Holmes, of the University of Durham, will open in Boston on March 4.

The forty-eighth meeting of the American Association of Anatomists will be held in New York at the Medical Center of Columbia University on March 24, 25 and 26. An exhibit of preparations, models and methods will be held in connection with the meeting.

The annual spring meeting of the New York Branch of the American Psychological Association will be held in Philadelphia, at the University of Pennsylvania, on April 9.

The International Mathematical Congress will be held in Zurich from September 4 to 12. Titles of papers intended for presentation should be sent to the Secretary of the Congress, École Polytechnique Fédérale, Zurich. The president of the committee on organization is Professor R. Fueter. The International Mathematical Union, a distinct organization, of which Professor W. H. Young is the president, will meet during the time of the congress.

Formal notice has been received from Dr. L. Joubin, Paris, president of the permanent committee of the International Zoological Congress, that the twelfth congress will meet in Lisbon in the summer of 1935 under the presidency of Professor Artur R. Jorge, professor of zoology at the University of Lisbon.

The Ninth Congress of the International Society of Surgery will be held at Madrid from March 15 to 18. At the same time there will be an exhibition of surgical instruments, orthopedic apparatus and pharmaceutical preparations, under the organization of Dr. F. Coca, Lagasca 38, Madrid.

By the will of the late Lewis Cass Ledyard the New York Public Library receives $2,000,000 and the Morgan Library $250,000.

The estate of Miss Lydia Thompson Morris, the value of which is estimated at $4,000,000, will be apportioned as provided under the will of her brother, John T. Morris, who died some years ago. Mr. Morris's will provided that after his sister's death, Compton, a 170-acre estate regarded as one of the country's finest arboretums, should pass to a corporation to be known as "The Morris Botanical Garden, School and Museum." Its endowment will come from the residue of the estate. Mr. Morris also provided that after his sister's death the Philadelphia Home for Incurables should receive $250,000 for a new building and the Historical Society of Pennsylvania $10,000; two trust funds of $25,000 each are to be established for the Pennsylvania Museum and School of Industrial Art and a similar one for the Academy of Natural Sciences; the Franklin Institute received $20,000 and smaller sums are bequeathed to societies, schools, hospitals and libraries.

The late Frederic S. Pepper, Jr., of Philadelphia, who lived for many years as a recluse, provided in his will for a memorial to himself in the form of a $2,500,000 hospital for the "free care and treatment of sick and injured persons." Mr. Pepper directed his trustees to set aside a similar sum as an endowment to maintain the institution, which is to be erected as part of the University of Pennsylvania Hospital. Known as the Frederic S. Pepper Memorial, the hospital is to be erected and equipped when the principal and accumulated income of the residuary estate amounts to $5,000,000. Upon completion of the building, title is to be conveyed to the trustees of the university.

The Presbyterian Hospital of New York inherited $1,168,278 of the estate of Mrs. Helen M. W. Swan, who died on October 19, 1928. The hospital will receive $116,000 additional as the principal of five trust funds upon the death of the beneficiaries.

According to the *Journal* of the American Medical Association plans for the new $1,500,000 building for the University Hospital, University of Maryland, will be submitted to the board of regents at its next meeting. Funds voted at the last session of the general assembly will be made available in two instalments in February and August. Plans call for a 400 bed hospital in the shape of a cross, with provision for 250 training beds. The remaining accommodations will be for persons of moderate means, including a few private rooms. The building, which will be erected either on the site of the present hospital or in the vicinity of the other university buildings about Lombard and Greene streets, will be twelve or thirteen stories high.

The Italian government is planning to establish a graduate school in colonial medicine at the University of Modena. The school will provide courses of instruction for graduates in medicine, surgery and veterinary science, and will grant specialist diplomas.

Instruction will be given in pathology of colonial diseases, colonial hygiene, protozoology, bacteriology and serology.

THE Observatory at Lake Angelus, near Pontiac, known as the McMath-Hulbert Observatory, has been presented to the University of Michigan. It is equipped with new instruments for making motion pictures of celestial bodies. The gift is made by three amateur astronomers, all honorary curators of the University of Michigan Observatories. They are Mr. Francis C. McMath, consulting engineer; his son, Mr. Robert H. McMath, president of the Motors Metal Company, Detroit, and Mr. Henry S. Hulbert, senior judge of probate in Detroit.

AT a meeting of the president and fellows of Harvard College on January 11 it was voted to establish the Botanical Garden in Soledad, Cuba, as a branch of the Arnold Arboretum, to be called the Atkins Institution of the Arnold Arboretum.

THE herbarium of Mr. Charles C. Deam, recently acquired by the Indiana State University, contains over 60,000 specimens, on which he has based his books on the trees, the shrubs and the grasses of Indiana.

A *MEETING* of horticulturists was recently held at the headquarters of the Royal Horticultural Society, London, to discuss the establishment of a central research station as an aid to securing the fullest benefits of the tariff on imported horticultural products. Mr. H. A. Tipping, who presided, said the time was opportune, because of the "Buy British" movement, to establish such a station. If the matter were left to the government it would take a long time to get anything done, and it would be still longer before any results were obtained. There were well-equipped laboratories at Wisley which would make a very good beginning for such a project. Mr. J. W. Barr, who organized the meeting, explained how a central research station would be of value to the horticultural industry in dealing with problems which required research in the laboratory or in private culture, and in securing better and more economical methods of production. He pointed out that according to official figures the annual importation of bulbs alone exceeded £1,000,000 in value. With a few exceptions these could be produced in England, if the growers possessed more knowledge of culture and propagation. Sir William Lawrence suggested that the quickest way to achieve the desired result would be to get instructors from Holland and elsewhere to teach the growing and harvesting of bulbs and early vegetable crops. A resolution was carried recording that in the opinion of the meeting a central research station should be established and requesting Mr. Barr to approach the trade organizations with regard to the setting up of a working committee.

DISCUSSION

DISCOVERY AND DISCOVERERS

IN his spirited appreciation of Schaudinn, the discoverer of *spirochaeta pallida,* Professor John H. Stokes[1] makes a serious historical omission when he states that Metchnikoff with Roux "had accomplished the first successful transfer of syphilis to apes" in 1905, for this was done already in 1875 and 1877 by Edwin Klebs. His publications[2] on the subject can amply confirm this. The fact is generally accepted, at least by those who are not overawed by the clamors of certain "microbe hunters" who date all advance in etiologic research from Koch, relegating to the antiquarian rubbish heap what came before from the brains and hands of Pasteur, Lister, Klebs and others. Metchnikoff himself was one of those, for he told me some years ago that he had not the slightest doubt that Klebs was the first to have seen the *spirochaeta* and the first to have successfully inoculated apes with syphilis.

On reading carefully the two reports which antedate by nearly thirty years Schaudinn's discovery, one comes to realize at once why Klebs held in those years the undisputed leadership in an entirely new field of research. He possessed to a far greater degree than his contemporaries and coworkers in the same field (notably Pasteur, Lister and Koch) an unrivaled experience in pathological morphology, a very keen eye for microscopic analysis combined with a versatile technical talent. Stokes is amazed by Schaudinn's "astounding eyesight," which allowed him to dispense with a satisfactory dark-field equipment, substage condenser, etc. Klebs' equipment was still simpler, and again simpler was that of a Leeuwenhoeck, of a Bichat, who all made brilliant contributions to our knowledge of microscopic life—so brilliant indeed that one sometimes wonders whether we are not getting spoiled by too much and too refined an equipment.

The report under consideration states: (1) that in syphilitic lesions there are regularly found spirillar organisms, slender motile rods 2 to 5 microns long, which seem to belong in Ehrenberg's botanical group of monads, and which Klebs names, because of their spirillar shape, *"helico-monads"*; (2) cultures of these organisms are obtained on a special medium of isinglass jelly; (3) successful transfer of syphilis to animals was obtained only in apes (*macacus*), very suggestive but not entirely conclusive results in the case of subcutaneous inoculation of culture material (July 8, 1875), entirely conclusive in the case of inoculation with freshly excised material from a human primary lesion (December 29, 1877). At this distance we have of course no means to control the exactness of all these findings. They are certainly impressive in view of the similar later findings. From what Professor Ghon told me some years ago, the pathological institute in Prag still has the skull of the second ape with the very characteristic lesions.

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[1] SCIENCE, 74: 502–6.

[2] Edwin Klebs, "Ueber Syphilisimpfung bei Thieren und über die Natur des syphilitischen Contagiums" (Vortrag 51. Versamml. Deutsch. Naturf. u. Aerzte, Cassel), *Prag. med. Wochenschr.*, 3: 409, 1878; "Das Contagium der Syphilis; eine experimentelle Studie," *Arch. f. exper. Pathol. u. Pharmakol.*, 10, 161 (4 plates), 1879, Nachtrag: F. J. Pick: Mittheilung üb. d. s. Impfung verwendet. Fälle.

If attention is called here to these overlooked facts, it is not done with the intention of making a claim for priority or for historical justice. It is unnecessary, for good work can stand on its own feet, and anyway, as Bertrand Russell might say, its neglect by others has no "cosmic importance" whatever. But it is of human interest, if not of importance, to note from these diggings in the past the two historical phases in etiological research. Leaving the broader, pathological consideration of the rôle of microorganisms in animal economy, research assumed the form of a vast enterprise with the elaboration of a highly specialized methodology which focuses attention exclusively, or almost so, on the microbe or virus, forgetting, or at any rate neglecting the fact that there is a human structure, a whole man, "himself a biological problem of no mean order," as Stokes well remarks. That the fruitfulness of an original idea is extinguished by the weight of subsequent methodological refinements is nothing new in history. The impressive edifice of medieval scholasticism erected upon Aristotelian and Platonic ideas is *the* gigantic monument to these vicissitudes of human thought. And do we not sometimes detect in the experimental subtilizations of modern research a resemblance to the scholastic method of syllogistic hair-splitting?

Results of course ought to tell. For the case under consideration Stokes notes regretfully that Schaudinn's discovery "has never yet been carried to its logical outcome for practical medicine," and that even the chemo-therapy which it directly incited "was, in a sense, a premature blooming." But one marked effect it did exert. It called forth a very rapid acceptation by the profession which was expressed, Stokes says, in the appearance of 750 articles in about one year. In view of the negative practical results was there really a compensating theoretical gain in such literary overproduction? One has reason to doubt it when one sees how the bulk of the literature is swelled by purely classificatory and methodological reports which effectively screen a hustling world of workers from a view of the things that really matter. If we have made so little advance in the twenty-five years after Schaudinn's discovery, so that we do not know any more about syphilis than Klebs knew fifty-five years ago, it seems high time that we ask ourselves whether both theory and method are not defective somewhere. Luckily this question is being asked ever more audibly.

Another more general question is asked by Stokes as to the relative value in modern investigation of "genius" or the man of "persistent singleness of purpose" by which he means the strictly limited, specialistic worker. He declares himself for the latter, being dubious about "genius," though he thinks he "may still perhaps scatter over the whole field of a science a series of germinal or epochal discoveries." Hence he is not quite ready to agree with the Soviet delegates who last spring, at the History of Science Congress in London, pleaded with no mean dialectic ability for a history which was not "biographical apologetics or apologetic biography. . . Only when science itself is understood to be a function of society can there be given a scientific history of knowledge. Only because knowledge is an integral part of social life, is the history of knowledge an integral part of history."[3] Our current histories, our current speech, it must be admitted, utter the word "genius" too frequently and too loosely. It may easily be argued that in science there only once was a genius and that his name was Aristotle, for not only his fame but his contribution to thought have endured two thousand five hundred years, and it still influences us in every phase of scientific activity. "Genius" derives from sexual propagation, but the goodness of its productions can not be measured by the tons of lifeless paper—it has only a living measure in time. Indeed "art is long and life is short."

ARNOLD C. KLEBS

NYON (SWITZERLAND),
NOVEMBER 10, 1931

A NEW AUTOTROPHIC BACTERIUM WHICH OXIDIZES AMMONIA DIRECTLY TO NITRATE AND DECOMPOSES PETROLEUM

IN connection with the studies of the senior author[1] on living microorganisms in ancient rocks an attempt was made to determine whether or not other old materials than rocks harbor living microorganisms. Among such materials studied was petroleum. An attempt to find cellulose destroying organisms in petroleum, by inoculating the latter into a cellulose medium, yielded an organism which apparently has no power to decompose cellulose but which has an extraordinary physiology. It was isolated from petroleum derived from a well over 8,700 feet deep owned by the Standard Oil Company of California. The organism is a coccus or cocco-bacillus, variable in size and somewhat so in shape. It grows very well under strictly autotrophic conditions in an inorganic salt medium with ammonium sulphate or potassium nitrate as the source of nitrogen. It oxidizes ammonia directly to nitrate without passing it perceptibly through the intermediate step of nitrite formation, as do the group of bacteria known as nitrifying bacteria. The nitrate-producing power, moreover, is manifest very quickly under such conditions—much more so than is true of the nitrifying bacteria. It is apparently a facultative aerobe and a facultative autotroph. In addition it possesses the power of completely decomposing petroleum without apparent gas formation aside from the end-product gas-carbon-dioxide.

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[3] N. Bukharin: In symposium on "The Sciences as an Integral Part of General Historical Study," June 30, 1931 (mimeographic report). The subject is also discussed in the same manner in SCIENCE (p. 497, Nov. 20, 1931) in the interesting and valuable address of Professor Cecil H. Desch.

[1] *Jour. Bact.*, 22: 3, 183, September, 1931.

We have noticed in the literature two or three cases in which organisms isolated from soil were described as possessing the power to oxidize ammonia directly to nitrate. These reports have never been confirmed and the other powers attributed to our organism above have not been indicated in such earlier reports. A full account of our investigation with this remarkable organism will be published elsewhere, together with a comparison of our results with those of Kaserer, Söhngen and others whose work has a bearing on the subject under discussion.

CHAS. B. LIPMAN
L. GREENBERG

UNIVERSITY OF CALIFORNIA

GROWTH INHIBITION OF POTATO SPROUTS BY THE VOLATILE PRODUCTS OF APPLES

VOLATILE substances from ripe apples have been found to inhibit the normal sprout development of germinating potatoes. Potted germinating seed pieces, held under favorable conditions for growth and placed in closed containers or in closed rooms with ripe apple fruits, have uniformly produced sprouts which failed to develop normally. Apical growth of the sprouts is practically stopped and small stem-tubers instead of normal sprouts may develop. When non-germinated seed pieces are placed under the influence of these volatile substances, bud dominance in potato eyes is largely overcome and abortive multiple sprouting results.

Inhibited growth due to the volatile products from apple fruits has been observed with the following six potato varieties obtained from six different states: Irish Cobbler, Bliss Triumph, Russet Burbank, Spaulding Rose No. 4, Early Ohio and an undetermined variety. The volatile substances from the four apple varieties, Winesap, Stayman, Jonathan and Ben Davis, have caused the inhibition. The inhibitory effect was obtained from peeled apples as well as from the unpeeled fruits.

No growth inhibition has resulted from the volatile substances of oranges, bananas, decayed apples or from iso-amyl-valerate (apple oil). Immature apples did not produce normal growth arrestment, but these same fruits, after ripening, produced the inhibition. In a single test where ripe Kieffer pear fruits were used with germinating potatoes, growth inhibition similar to that produced from ripe apple fruits resulted.

The effect of the volatile products of apples is transitory, and normal sprout development takes place after potatoes are removed from their influence.

In a preliminary test, potato tubers stored with apples in closed containers until June remained firmer and of better quality than did the control tubers.

O. H. ELMER

KANSAS AGRICULTURAL EXPERIMENT STATION

BREAKING THE DORMANCY OF TREE SEEDLINGS BY CHEMICAL TREATMENT

IN connection with the ethylene chlorhydrin treatment used by Deuber and Bowen[1] to shorten the rest period of sugar maple seedlings, it may be of interest to report a similar treatment recently given to both sugar maple (*Acer saccharum*) and chestnut (*Castanea dentata*) seedlings.

A dozen sugar maple seedlings, four feet in height, were potted and brought into the greenhouse during the early fall before there was any change in their summer foliage. They were kept under warm greenhouse conditions, where they did not experience the normal seasonal changes during the fall and winter. When spring came and the outside trees began growth these greenhouse seedlings remained dormant, and, it became evident that it would be necessary to substitute some artificial treatment for the normal winter exposure in order to break their dormancy. This was accomplished by keeping them exposed for a period of three days to the vapors from 25 milliliters of ethylene chlorhydrin diffused in 450 liters of air space. One half of the potted seedlings were so treated and the remainder left as checks. In making this treatment, the chemical was absorbed by a small piece of cotton and placed with the seedlings in a tightly sealed, metal chamber of the type used for seed sterilization. Any tight container could have been used in place of such a chamber. The treatment was given during the first two weeks in June, and by the first of July all the treated trees were in partial or full leaf, while the untreated trees remained dormant. Although a number of the latter slowly came into activity a month later, indicating that they were not dead, their foliage was not fully developed in September.

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[1] C. G. Deuber and P. R. Bowen, "Chemical Treatment to Shorten the Rest Period of Sugar Maple Trees," SCIENCE, July 26, 1929.

By a similar treatment a number of chestnut seedlings were made to break their rest period three months in advance of the normal season. The concentration of ethylene chlorhydrin was the same as that used for the sugar maples above, but the time period was four instead of three days. This treatment, while successfully breaking their dormancy, killed back the ends of the upper branches to four inches from their tips, and evidently a shorter time period or a lower concentration of the chemical is to be recommended in order to avoid injury. These seedlings were treated during the second week of January, and by the first of February their buds were breaking into activity.

The results of the treatments indicate that the vapors of ethylene chlorhydrin may be successfully used to break the dormancy of some tree seedlings. The chemical seems to be toxic to young branches at higher concentrations, but when properly regulated it has proven to be very useful for breaking the rest period of both sugar maple and chestnut seedlings.

William C. Bramble
Osborn Botanical Laboratory,
Yale University

DUST PARTICLES

The mongrel mixture of detritus called "dust" in the household, is commonly found precipitated on walls (*e.g.*, where radiators or leaks in window casings or door jambs produce air currents), or on protected areas of floors (*e.g.*, under beds or other furniture). The phenomenon is something quite apart from the quiet settling of fine particles according to Stokes's law, which causes the ordinary layer of "dust." It seems to involve an electrical precipitation and/or aggregation, whereby particles which have specific surface charges or which have become charged by adsorption of atmospheric charges (electrons, ions or smaller particles), attach themselves to wall areas or to other particles having opposite specific or net charges.

It would be an interesting research to see to what extent (if any) dust becomes charged by metal or other radiating surfaces, by friction due to air currents, and by sunlight. That horror of efficient housewives, known in New England as "house-moss," appears to consist of a fluffy mat of adventitious fibers (cotton, wool, linen, silk), whose electrostatically active surfaces aid in holding them together and in fixing on them other kinds of dust particles.

Jerome Alexander
New York City

THE NERVOUS CONTROL OF HEMATOPOIESIS

Since the theories of hematopoietic control are still widely at variance, a series of tests was carried out to attempt to determine the rôle of the nervous system in the liberation of erythrocytes.

Periarterial sympathectomy was performed on the left femoral artery of each of three dogs, while the unoperated right leg was left as a control. The dogs were killed with chloroform, nineteen, fourteen, and twelve days after operation, respectively. The femora were dissected free, split lengthwise, and marrow from similar levels was fixed in formalin for subsequent histological section.

In each of five dogs, the sciatic nerve on the left side was injected with 5 cc. of freshly distilled alcohol. This was followed in each case by a subsequent unilateral paralysis. These dogs were killed one week later and the femoral marrow was prepared for examination.

Neither in the cases of periarterial sympathectomy, nor sciatic injection, were observable differences present between the marrows of the operated and the control sides.

These results are in keeping with the observations of Drinker, Drinker and Kreutzmann[1] (1917) who report that they found no outpouring of normoblasts after the complete section of sciatic and brachial plexuses.

Joseph Krafka, Jr.
Department of Anatomy,
Medical School, University of Georgia

POSITION OF WOOD IN BEAVER DAMS

Mr. Charles Macnamara brings up an interesting question in Science for December 18, 1931, with regard to the position of wood in beaver dams. At one time I did think that the most usual way for beavers to begin a dam was to lay the first sticks with the butt ends upstream. However, the more I study the construction of beaver dams the more evident is it to me that the animals have no set rules about it. I have seen dams that were just started where the butt ends of the sticks were laid upstream, and I have seen them where they were laid downstream. I have a photograph showing the latter condition where a dam was built across a stream and the beavers were extending it on to the gravelly shore or bank. Here it was plain that the willows were laid with the butt ends downstream.

In broken dams there are always the ends of many sticks projecting into the open gap, showing that they are lying lengthwise of the dam, presumably intentionally placed in that position by the builders, but who can tell? The discarded food branches and other sticks drift and lodge against the upper side of the dam, and if that is raised such material would be incorporated in the dam and would lie lengthwise, just as it had lodged. I have sometimes wondered if the settling of a dam might not at times cause enough movement to twist the sticks from their original up-and-down stream positions to others at varying angles.

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[1] C. K. Drinker, K. R. Drinker and R. L. Kreutzmann, *J. Exp. Med.*, 27: 249, 1917.

In one case where high water broke a dam the beavers closed the gap with sticks placed across it without any system whatever. They seemed to have just brought the material and dropped it, leaving it to adjust itself; but the opening was effectually closed and the dam as good as ever.

The strength of beaver dams is remarkable. I have seen several instances where high water has broken a dam, forced a section of it downstream and turned it to one side, leaving it still attached to the dam at one end.

Since 1913 I have kept up fairly continuous observations on the work of beaver on streams not far from my home, as well as observing the work of the animals wherever I have had an opportunity, and am continually coming upon some new thing, often something which makes one wonder why it was done. There is still plenty to be learned about beavers, or any other wild animal, for that matter.

Edward R. Warren

Colorado Springs,
Colorado

SPECIAL CORRESPONDENCE

A NEW CONNECTION BETWEEN MAGNETISM AND ELECTRICITY

Under the highly technical name of "Quantised Singularities in the Electromagnetic Field" there has just appeared a paper in the current issue of the *Proceedings* of the Royal Society of London (September, 1931), that promises to be of great importance. Dr. P. A. M. Dirac, its author, is one of the most brilliant of contemporary physicists. He is a fellow of Trinity College, Cambridge, and is at present a guest of Princeton University.

According to classical theory, magnetism is a property of certain bodies—how they behave. The molecules of a substance are regarded as elementary magnets because of the existence of a system of electric currents within each molecule. This is ascribed by modern physics as due to the orbital revolutions of the electrons inside the molecules. Under ordinary conditions there is a haphazard arrangement of these molecules or elementary magnets, and consequently no resultant magnetic effect is manifested. In order that the magnetic effect of each molecule be additive, the molecules as magnets must be orientated in the same direction. If all the molecules are orientated in the same direction the substance is said to be saturated with magnetism. Thus the magnetic character of a body is said to be due to its polarization, that is, to the regular arrangement of its molecules. This view permits one to correlate magnetism with the electric current instead of regarding it as a new phenomenon. One of the most forceful arguments for not regarding magnetism as the manifestation of a separate entity instead of a property, is that no one has ever succeeded in imposing upon a body a charge of either positive or negative magnetism only, although it is a familiar fact that one can charge any body either electro-positively or electro-negatively.

In trying to discover the reason for the existence of the electron, the smallest electric charge, Dirac found that his calculations led instead to a relation between the smallest electric charge and the smallest magnetic pole. This type of connection between electricity and magnetism has never been suspected and is quite foreign to the current idea of magnetism, which was sketched very briefly in the preceding paragraph. It means that modern quantum theory allows the existence of isolated magnetic poles, the strength of which must be quantised. Just as the charge of any particle must be an integral multiple of e, the smallest electric charge, so the strength of any isolated magnetic pole must be an integral multiple of the smallest magnetic pole. The elementary quantum pole u_0 is connected with the elementary electric charge e by the relation $\frac{hc}{eu_0}=2$ or $u_0=\frac{hc}{2e}$ (where c is the velocity of light and h is Planck's constant divided by 2π). This, of course, is not a perfectly symmetrical relation between electricity and magnetism. To be perfect it would have to be $u_0=e$. It would be unusual if nature did not take advantage of the possibility of discrete magnetic poles, the existence of which is consistent with the quantum theory. Why, then, have such objects never been observed? There is a relation in physics which gives the experimental value of the smallest charge of electricity, independent of any theories, as $\frac{hc}{e^2}=137$. When this is combined with the relation given above we get $u_0 = \frac{137}{2} \times e$. That, is the attractive force between two one-quantum poles of opposite sign is $\left(\frac{137}{2}\right)^2$, or almost 5,000 times as great as between an electron and a proton!

If isolated magnetic poles were common, the universe would be quite different from what it is. Although electrons and protons which go to make up matter are very much more abundant than these magnetic poles, still there is a possibility that somewhere in the universe there may exist a new kind of substance, made up of these magnetic atoms, and containing much more energy than the matter we are familiar with. Professor O. W. Richardson discusses this possibility in *Nature* of October 3, and is of the opinion that although it would be rather difficult to create objects with the intrinsic energy of these magnetic poles, still there may be enough of them to account for such ultra-penetrating radiations that can not be explained in any other way. At any rate, cosmology will have to consider in the future the possibility of existence of these isolated magnetic poles. To the electron, proton, and photon which go to make up the universe, another entity, the magnetic pole, may have to be added. First electricity, and then light, and now magnetism have proved to be discontinuous!

Alexander W. Stern

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE APPARATUS FOR MERCURY DISTILLATION

For laboratories in which a considerable amount of pure mercury is used, for example, for the purpose of gas analysis, it is advantageous to have the equipment for redistillation. At the Animal Husbandry Division of the University of California in Davis we are using an inexpensive apparatus for mercury distillation which works very satisfactorily.

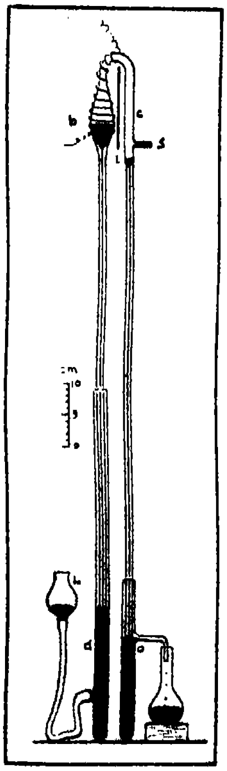

Fig. 1.

The distillation bulb of Pyrex glass b (see Fig. 1), which is 4 cm wide and 9 cm long, is connected at the top to a U tube 1.5 cm wide, which has a capillary side outlet S. The lower end of the U tube and that of the distillation bulb are each connected to a barometer tube of approximately three millimeters bore. Each of the two barometer tubes is put in a slightly wider glass tube, as shown in the sketch. The tube d on the left side contains impure mercury (which, however, is to be free of volatile contaminations) and is provided with a side outlet connected by a rubber hose to a leveling bulb L, which enables one to adjust the mercury level in the distillation bulb. The tube o on the right side contains clean mercury and has also a side outlet through which the distilled mercury overflows into a flask.

For the first start of the apparatus the outlet S is connected to a suction pump (we used an ordinary filter pump) so that the mercury rises in both barometer tubes, the impure mercury up into the bulb as shown in figure. The bulb is then heated electrically by a simple coil of resistance wire (we apply 320 watts). The wiring should begin at the height of the mercury level in the bulb. In this case the evaporation takes place only at the free surface of the mercury and there is no bumping and splashing. The wiring should be continued up to the top of the U tube, as otherwise a running back of the condensate occurs which decreases the efficiency of the apparatus. A piece of asbestos paper i protects the condenser tube from the heat of the electric coil. The cooling of the condenser by air alone has proved to be sufficient. After the mercury has evaporated for several minutes during suction the air in the apparatus is practically displaced by mercury vapor, then the outlet S is sealed. The apparatus is now ready for use *ad libitum* as it maintains its own vacuum. All one has to do is to add contaminated mercury to the leveling bulb L, to empty the clean mercury from the collecting bottle and to open the electric current in order to stop, or to close it in order to start the distillation. The apparatus does not need any further attention. It is vapor proof insofar as no hot mercury comes in contact with air. The contaminated mercury in L and d which by variations in pressure at the beginning of the distillation may get warm may be covered with water for safety. The apparatus as described distils 25 cc of mercury per hour.

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IMPROVED STAINING TECHNIQUES FOR THE DEMONSTRATION OF NON-ACID-FAST TUBERCLE BACILLI AND GRANULES

The two staining methods here described are improved counterstain techniques for the demonstration of non-acid-fast tubercle bacilli and granules. Both methods gave more effective color contrasts between acid-fast and non-acid-fast bacilli than the counterstains employed in the Ziehl-Neelsen,[1] Gram,[2] Cooper,[3] Kühne,[4] Fontes[5] and Dreyer[6] methods. The improved methods consist in adding alkali (NaOH, Na_2CO_3, or $NaHCO_3$) of an experimentally determined optimum strength and amount.

The organisms employed in this study were ten-day cultures of an avian strain of tubercle bacilli obtained from Bellevue Medical College. They were grown on a glycerine potato agar medium which contained, in the case of some slants, 10 per cent. normal horse serum, and with other slants 10 per cent. immune rabbit serum. After the usual 5-minute staining period with Ziehl-Neelsen carbol-fuchsin according to the Ziehl-Neelsen method for staining tubercle bacilli, destaining with 3 per cent. HCl alcohol, and washing with tap water, the slides were counterstained according to the techniques described below.

Counterstain Method I

Flood the smear with 8 drops of Löffler's methylene blue. Add immediately 6–8 drops of 0.05 per cent. NaOH from a medicine dropper. Move the slide gently from side to side to mix, and let stand two to three minutes. Wash with tap water, dry and examine under the oil immersion lens. The contrast between the red acid-fast tubercle bacilli and the blue non-acid fast tubercle bacilli is striking.

Counterstain Method II

Flood the smear with 8 drops of 1 per cent. aqueous crystal violet solution. Add immediately 6–8 drops of 5 per cent. $NaHCO_3$. Move the slide gently from side to side to mix, and let stand not more than 2 minutes. Wash in tap water, apply Gram's iodine for 2 minutes, wash, and decolorize 20–30 seconds with a mixture of equal parts of acetone and 95 per cent. alcohol; wash, dry, and examine under the oil immersion lens. The non-acid-fast bacilli appear violet. In addition the "granules" in the red acid-fast bacilli and in the violet non-acid-fast bacilli stand out prominently as violet-black bodies.

With Löffler's methylene blue solution, it was found that 0.05 per cent. NaOH, 0.1 per cent. NaOH, 1 per cent. Na_2CO_3, and 10 per cent. $NaHCO_3$ gave about equally satisfactory results. Both higher and lower concentrations of these solutions, for example, 1 per cent. and 0.01 per cent. NaOH, 10 per cent. and 0.5 per cent. Na_2CO_3, 5 per cent., 1 per cent., and a highly supersaturated solution of $NaHCO_3$, gave less effective results. Control slides using Löffler's methylene blue without additional alkali, also gave less effective results.

With the 1 per cent. aqueous crystal violet solution, 5 per cent. $NaHCO_3$, 0.5 per cent. Na_2CO_3 and 0.05 per cent. NaOH gave the most satisfactory results.

All the chemical solutions used were freshly prepared in clean sterile bottles.

The above results suggested that there might be an optimum pH zone within which the above counterstains can most effectively penetrate and stain the non-acid-fast tubercle bacillus. The pH's of the alkali solutions tried out were determined colorimetrically with the following results:

Indicator	Alkali	Dilution Per cent.	pH
Trapaeolin O (range 11.1–12.8)	NaOH	0.01	11.4
		0.05	11.9
		0.10	12.2
	Na_2CO_3	0.50	11.4
		1.00	11.7
		5.00	11.9
Thymol Blue (range 8.0–9.6)	$NaHCO_3$	1.00	8.6
		5.00	8.4
		10.00	8.3

The relatively low pH shown colorimetrically by the $NaHCO_3$ indicates that the hydroxyl-ion concentrations of the above solutions do not constitute the sole factor in determining the permeability of the bacterial surface to the dye solution, and the penetrability and fixation of the dye. The ionic activities[7] of these solutions, the degree of dispersion of the dye, and other factors[8] must be considered.

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[1] Park and Williams, "Pathogenic Microorganisms," p. 85, 1929.

[2] *Ibid.*, p. 82.

[3] *Ibid.*, p. 86, also *Arch. Path. and Lab. Med.*, 2, 382, 1926.

[4] Calmette, "Tubercle Bacillus Infection and Tuberculosis in Man and Animals," p. 16, 1923.

[5] *Ibid.*, p. 21, *Centralbl. f. Bakt.*, 49, 317, 1909; also Kieffer, *Am. Rev. Tuberc.* 5, 662, 1921.

[6] G. Dreyer and R. L. Vollum, *Lancet* 220, 1015, 1931.

[7] Lewis and Randall, "Thermodynamics," p. 35, 1923.

[8] J. W. Churchman, in "The Newer Knowledge of Bacteriology and Immunology," (Jordan and Falk), pp. 19–37, 1928.

Trials of these counterstaining techniques have been made on several bovine and human strains with satisfactory results. The concentrations of the alkali solutions required to stain effectively the non-acid-fast bacilli and granules of these strains, were found to be higher than those required for staining the avian bacilli. Best results for the bovine and human strains stained according to Method I, were obtained with 1 to 5 per cent. NaOH and 3 to 10 per cent. NaOH respectively, whereas the highest optimum NaOH concentration found for any of the avian cultures studied was 0.5 per cent. With Method II, both bovine and human bacilli gave effective results with saturated $NaHCO_3$. With Na_2CO_3, best results for bovine bacilli were obtained with a 5 per cent. solution, and for human bacilli with a 10 per cent solution.

Further study is being carried on to determine whether or not these staining techniques may be of use in differentiating avian, bovine, and human types of tubercle bacilli.

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SPECIAL ARTICLES

POLIOMYELITIS AS AN ESSENTIAL NERVE SYSTEM DISEASE THROUGHOUT ITS COURSE

IN 1912, Peabody, Draper and Dochez[1] in their monograph on acute poliomyelitis postulated a preliminary period of generalized systemic infection preceding invasion of the nervous tissues. Since the publication of their hypothesis and its reassertion by Draper[2] in 1917, the conception of poliomyelitis as essentially a general infectious disease with secondary and incidental invasion of the nervous system has come to be widely accepted and has largely governed medical thought in the fields of epidemiology, clinical interpretation of the early symptoms and serum treatment. That it has stood at variance with much of the experimental work—such as the great difficulty of producing the disease in apes by intravascular injection of virus, as contrasted with the great ease of producing the disease by direct applications to nervous tissue—and with certain clinical aspects of the disease in man, such as the peculiarly scattered and asymmetrical distribution of the lesions and paralyses, must be evident to any unbiased student of poliomyelitis.

An analysis of the 115 case histories given in the Rockefeller Monograph and in Draper's book with special reference to the onset symptoms shows no necessity for assuming an early phase of systemic, extranervous infection, but on the contrary that all the most frequent and characteristic onset symptoms can be explained as manifestations of infection of the central nervous system. In order of frequency, the commonest onset symptoms in the 115 cases were found to be: fever; vomiting; drowsiness, restlessness and irritability; headaches; vague symptoms, usually subjective, of discomfort or awareness of bodily disturbance; pain or hyperesthesia, and constipation. Each of these, and none of the other symptoms, occurred in more than 10 per cent. of the cases. To them should be added a peculiar psychic change which Draper regards as specific and as characteristic of the earliest hours of the disease, but is not shown in the actual protocols. Considered as a group, the symptoms are abviously of a nervous order. Moreover, these same symptoms, together with others indicating an extension in nervous involvement, almost equally characterize the later stages of the disease. It is notable that in the "dromedary" cases in which an interval of symptomatic silence separates the initial symptoms from those of the later, indubitably nervous phases of the disease, the predominant symptoms of the onset recur with significant frequency during the later phases. An analysis of the sites of residual paralysis in the large series reported by Lovett and Lucas[3] shows them to be one-sided in over three quarters of the 628 cases.

If the theory of initial, systemic invasion were correct one would logically expect: (1) a notably different symptomatology in the initial and later periods of the disease; (2) a diffuse or at least a symmetrical distribution of the lesions and paralyses. Differences in the blood supply of the two lateral halves of the bulbospinal axis, such as have been offered in explanation of the asymmetry of the lesions, probably do not exist: if they did, they would fail to explain, in the absence of gross embolism, which is not a feature of the pathology, the prevailing one-sidedness.

The clinical aspects of poliomyelitis harmonize, in my opinion, satisfactorily with the newer conception of axonal transmission of virus proposed in 1930 by Fairbrother and Hurst (which represents a return, with some modifications, to the conception of nerve transmission held by nearly all the early investigators) and very poorly with the hypothesis of initial, extra-nervous invasion. The generalized lymphoid hyperplasia found post-mortem is a secondary phenomenon. The subject will be dealt with at length in a paper which has just been submitted for publication in a medical journal.

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[1] F. W. Peabody, G. Draper and A. R. Dochez, "A Clinical Study of Acute Poliomyelitis." Monographs of the Rockefeller Institute for Medical Research. No. 4, June 24, 1912.

[2] George Draper, "Acute Poliomyelitis." P. Blakiston's Son and Company, Philadelphia, 1917.

[3] R. W. Lovett and W. P. Lucas, "Infantile Paralysis. A Study of 635 Cases from the Children's Hospital, with Especial Reference to Treatment." *J. A. M. A.*, 51, 1677, November 14, 1908.

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THE NON-IDENTITY OF "PURE" AND "ISOELECTRIC" GELATINS

IN a recent text on biochemistry one of the writers (R. J. W.) made the statement, which is contrary to J. Loeb's conceptions, that "pure" and "isoelectric" gelatin are not identical. The validity of this statement and the clarity of the argument has been questioned, probably due primarily to the fact that no experimental confirmation was cited.

We have within the past year actually performed experimental work which seems to check this conclusion, and are therefore presenting it briefly at this time. The theoretical basis for the case must first be summed up.

If we possessed an organic ampholyte which by its chemical nature was exactly neutral in character, a solution containing nothing but this pure ampholyte and water would obviously be neutral in reaction and furthermore would be at its isoelectric point because the tendency to ionize as an acid and as a base would be exactly balanced.

If, however, we were to dissolve in pure water an ampholyte which is slightly more of an acid than a base, the solution would be slightly acid instead of neutral, and the material would *not* be at its isoelectric point, because by nature it ionizes more readily as $H^+ X^=$ than as $Y^+ OH^=$. In an electric field the substance should migrate to the anode because of this unbalanced tendency to ionize in the two ways. In order to bring such a solution to the isoelectric point of the ampholyte, one would have to add a small amount of acid to the solution. This would repress the acidic ionization of the ampholyte and increase its basic ionization.

Gelatin is, by any process of reasoning, a slightly acidic substance (or mixture of such substances). In its make-up there is a preponderance of acidic amino acids, and when amino acids are combined in the peptide linkage the resulting products are more strongly acidic than the original amino acids. Gelatin belongs, therefore, to the latter type mentioned above. A solution of "pure" gelatin would not be neutral and would likewise not be at the isoelectric point of the gelatin. A slight amount of acid would have to be added to bring it to this point.

Experimentally, we prepared three batches of electrodialyzed gelatin. These were washed with acetic acid and electrodialyzed according to the method used by one of us (L. F.) in previous studies on gelatin. The samples obtained yielded from 0.011 per cent. to 0.014 per cent. ash, which values are about one eighth as high as those of Loeb's "ash free" gelatin.

In three separate runs 0.5 per cent solutions of samples of electrodialyzed gelatin were subjected to from 4,600 to 5,100 volts potential in a two-compartment cell for from 70 to 90 minutes. The pH values of the original solutions in each of the cases were 5.2, 5.21 and 5.14. After subjecting the solutions to electrolysis, migration of the gelatin was noted in every case. The gelatin content of the anode portion after electrolysis was increased from 11 per cent. to 92 per cent. in the different experiments.

In another experiment a 5 per cent. solution of electrodialyzed gelatin with a pH value of 5.0 was electrolyzed in a similar manner. There was a 13.7 per cent. increase in the gelatin content of the anode compartment after electrolysis.

When one drop of normal HCl was added to a portion of the original 5 per cent. solution, the pH value was decreased to 4.52. Electrolysis of this acidified solution for 75 minutes resulted in a reversal of migration. There was a slight *decrease* in gelatin content of the anode portion, namely 2.3 per cent. This was expected, since the gelatin solution had been brought slightly to the acid side of the isoelectric point of the gelatin.

In summary we may state that when a solution containing electrodialyzed, non-ionogenic, "pure" gelatin was electrolyzed, a marked migration to the anode was noted. This appears to bear out the statement that "pure" gelatin and isoelectric gelatin are not identical. A similar statement applies to most other proteins as well as amino acids.

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AIR FILTRATION IN BACTERIOLOGICAL LABORATORIES

ONE of the conspicuous results of building operations near our laboratory during the past two years has been the increased amount of dust in the air. Laboratory tables and equipment accumulate a layer of dust if the windows are opened for any considerable time during the day. Some of the time the dirt even sifts in with the windows closed. This, coupled with the close proximity of the power house, has caused much extra work of wiping up the dust and sterilizing the table with mercuric chloride-alcohol solution. Extra care in manipulations has been necessary to avoid contaminations while making transfers or plating out samples.

Under these conditions, permission was granted to buy a small air-filtering apparatus designed for ventilating bacteriological transfer rooms. This apparatus, consisting of a blower fan and a filter, was installed in a window of a laboratory 12 by 20 feet and 15 feet high. It pushes filtered air into the room, forcing out the contaminated air through doors or any other opening. Although this room is larger than that for which the apparatus was designed, it was thought advisable to see whether conditions in the room could be improved for bacteriological work.

For testing the ability of the filter to reduce the number of microorganisms in the air of the room 5 petri dishes 120 mm in diameter, containing solidified nutrient agar, were exposed for three minutes on the laboratory table. The results of the first test were very interesting; before using the apparatus, exposed plates had an average of 15 colonies per plate after incubating four days. After three days' use of the filter, the average was 2 colonies per plate; one hour after stopping the apparatus and opening the window, the average was 16.7 colonies. The test was repeated about three weeks later with similar results.

The apparatus was then transferred to another room 9 by 20 feet and 15 feet high and installed in the transom over the door. Petri plates of nutrient agar were exposed for five minutes in the morning with the window and door closed and the air still. On these, an average of 19 colonies developed in four days. Plates exposed after the filter had operated ten minutes gave only an average of 5 colonies, whereas those exposed ten minutes after opening the window, had 20 colonies.

After several days' interval, the observations were contained in the same room, still without any special cleaning, with the following results:

	Average
Closed room, air still	16.6 colonies
After ten minutes operation of filter	3.4 colonies
After one hour operation of filter	8.8 colonies
Ten minutes after stopping apparatus	11.0 colonies
Ten minutes after opening window and door	20.0 colonies
One hour after opening window and door	19.2 colonies

These results show that in these laboratories, it is possible to greatly reduce the chance of air contamination of cultures by installing an air filter. There are two points, however, which make it inadvisable to use such a filter in an office laboratory. In the first place, the noise of the fan is distracting if one wants to do any except routine bacteriological work. In the second place, the temperature in every test was two to four degrees Centigrade higher in the room getting the filtered air than it was in the adjoining room with the window and door open. The only explanation of this seems to be that the air is heated that much as it is taken in over the motor of the fan. Of course, there are times when that would not be objectionable. As to its ability to furnish air free of microorganisms to a room, there can be no doubt. Petri plates, fifteen in all, exposed for five minutes each in the air current as it came from the filter remained sterile except in one case and then only one colony developed. Obviously, that was no fault of the filter.

The fact that the number of microorganisms suspended in the air is greatly reduced within ten minutes is interesting, as well as is the fact that the numbers seem to increase again, probably due to the stirring up of the dust in the room. For the present, it is planned to take advantage of this sudden reduction of suspended organisms by running the air-filtering apparatus only as it is desired to make transfers.

In these days when air-conditioning is beginning to be taken seriously, it may be well to look still further ahead to the day when conditioned and germ-free air will be forced not only into every bacteriological laboratory, but into every workroom where cleanliness is essential. In the meantime, an air filter, consisting of an electric fan and germ-proof filter offered for sale by a commercial firm, may be installed to force air freed of microorganisms into the transfer room and materially reduce the chance of contamination.

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BURNHAM, WILLIAM H. *The Wholesome Personality.* Pp. xv + 711. Appleton. $3.50.

CHAPMAN, FRANK M. *Birds of Eastern North America.* Pp. xxviii + 581. Illustrated. Appleton. $5.00.

CHIDESTER, F. E. *Zoology.* Pp. xii + 581. 267 figures. Van Nostrand. $3.75.

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SCIENCE

Vol. 75 FRIDAY, FEBRUARY 19, 1932 No. 1938

The Changing Effects of Race Competition: Professor S. J. Holmes 201

Scientific Events:
Convictions in the Calmette Serum Trial; The International Scientific Expedition; Scientific Problems of the Arctic; Committee on Noise Measurement of the American Standards Association; Support for Biological Abstracts 208

Scientific Notes and News 211

Discussion:
Asymmetric Valleys and Climatic Boundaries: Professor Kirk Bryan and Shirley L. Mason. *Meteoric Dust:* Dr. Willard J. Fisher. *The Oestrus-Producing Hormones:* Professor Edward A. Doisy and Dr. S. A. Thayer. *Stalactites and Stalagmites Growing above Ground:* Karl Ver Steeg. *Entoptic Colors:* Dr. Vernon W. Lemmon 215

Scientific Books:
Escherich's "Die Forstinsekten Mitteleuropas": Dr. L. O. Howard 218

Special Correspondence:
British Committee on Petrographic Classification: W. Campbell Smith and A. K. Wells 219

Scientific Apparatus and Laboratory Methods:
A Simple Device for Adding Load at a Steady Rate: E. L. Green. *Voltage-frequency Relationships in Action Currents:* Dr. Lee Edward Travis and Theodore A. Hunter 219

Special Articles:
The Effect of Cortico-adrenal Extract on Energy Output: Edward Eagle and Dr. S. W. Britton. *Vitamin G and the Growth Factor in Tomato Juice:* Dr. R. G. Daggs and A. G. Eaton. *Are Leaf Lipides Responsive to Solar Radiation?:* Professor W. E. Tottingham. *Effect of Dissolved CO_2 on the pH of Water:* Dr. Harold T. Byck 221

Science News 8

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THE CHANGING EFFECTS OF RACE COMPETITION[1]

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This evening I shall invite your attention to certain aspects of the contemporary evolution of our own species. In so doing I am sure that I need make no apology, especially since our society, through its traditions, is concerned with the general problems of organic evolution. Most of my hearers will doubtless recall the well-known address delivered by Professor Thomas H. Huxley on "The Struggle for Existence in Human Society." In venturing to discuss some aspects of this same subject I can not hope to emulate the clear and forcible presentation of this master of scientific exposition. Human rivalry takes on different forms as the years go on, and it is chiefly for this reason that I have chosen my present theme.

Man, like all other forms of life, is subject to the struggle for existence. He is exposed to the action of the various selective agencies which operate elsewhere in the organic world. Although selection acts upon all organisms, the way in which it acts, and whether it causes advancement, degeneration or mere lateral divergence, depends upon the peculiar circumstances under which an organism lives. The study of the influence of the selective agencies operating in the human species involves one in many complex problems. In man evolutionary changes are taking place with extraordinary rapidity. Probably nowhere else in the organic world is there a species which is undergoing such wide-spread and extensive modifications. Man is not only characterized by a degree of hereditary variability scarcely equaled by any other form of life, but he is subject to the operation of selective forces whose incidence varies greatly from place to place and from time to time. If we would understand the way in which the inherent qualities of human beings are being changed, for change they must, we must gain some insight into the action of the selective forces which determine what types of human beings have the greatest net rate of natural increase.

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[1] Address of the president of the American Society of Naturalists, New Orleans, December 31, 1931.

We are accustomed to look upon the struggle for existence as taking place according to a very simple formula. Organisms compete with one another; on the whole, the strongest, toughest or most intelligent survive and transmit their better adapted variations; and so the species comes slowly to be better fitted to its conditions of life. All this is very natural and obvious. But especially among us humans, matters do not work out so simply. Human survival and increase are conditioned by many factors which are not ordinarily included in our concept of the struggle for existence. The kind of human beings which tend to prevail may, for instance, be determined in part by religion and many other phenomena of our social inheritance. Social forces determine to a large extent how biological forces act, and as these social forces vary so greatly with time and place, the biological evolution of man comes to be influenced by a variety of factors which are non-existent in animals below man.

In considering the workings of selective survival in man we should distinguish between the operation of selection within groups from the operation of selection between groups. Both kinds of selection are actively working among human beings. The contention of many writers that natural selection has been practically done away with through the arts of saving life is, I am convinced, quite unjustified, and I have elsewhere defended the view that under present conditions of civilization natural selection is in several ways working more actively than ever before. However, although I may be alone in this opinion, I shall not defend it here, since my chief concern at present is with a somewhat different aspect of the problem.

Organized societies of animals behave as units in the struggle for existence. One group may drive out or exterminate another. We may therefore look upon evolutionary advance as resulting partly from improvements within each group and partly from the successive replacements of inferior by superior groups. The important rôle of group selection in man seems to have been first emphasized by Mr. Walter Bagehot in his original volume entitled "Physics and Politics," although the general doctrine had been stated by Darwin in his attempt to explain the genesis of the instincts of the hive bee. The concept of group selection came as a welcome adjunct to the theory of natural selection in its original form, because it supplied a plausible explanation of the genesis of many traits which could not be accounted for simply by the preservation of variations useful only to their possessors. The employment of the idea of group selection to explain the development of mutual aid, social sympathy, self-sacrifice and the various social and domestic instincts which make for effective cooperation is, of course, familiar to all students of evolutionary theory. The idea has bulked large in the writings of the so-called Social Darwinists. It has figured prominently in the literature of evolutionary ethics, and now and then it is given some consideration by the historians. Group selection in man is seen in its clearest form in the conquest and extirpation of one tribe by another. It is vividly illustrated in the wars of extermination waged by the Children of Israel against the unfortunate tribes who were not in the good graces of Jehovah. In this conflict of tribe with tribe which has gone on throughout untold ages we may assume that groups whose members were more intelligent, cooperative and willing to make sacrifices for the common welfare were, on the whole, successful. But intertribal struggles, to have evolutionary significance, must lead to replacement of the vanquished by their victorious competitors. The extent to which the replacement of stocks actually results from intertribal conflict varies greatly with the development of culture. Frequently the biological advantages of victory are partly nullified through the mingling of the blood of the victors and vanquished. With the advance of civilization humanitarian considerations commonly prevent the extermination of unsuccessful contestants. Where, however, conflicts occur between peoples on very different cultural levels, victory often affords an opportunity for the expansion of the more advanced group. The Anglo-Saxons have achieved remarkable biological success as a result of their conquest of more primitive peoples whom they found to be in the way. The proponent of the biological value of war can find good support for his thesis in the military career of this enterprising people. Many of the defenders of war on biological grounds are prepared to concede that the effects of military selection in removing the physically best of the male population are on the whole dysgenic, but they claim that the replacement of inferior by superior groups more than compensates for this influence. In wars between modern civilized states this replacement does not usually occur. The effects of victory are economic and political rather than biological, and the vanquished are as apt as not to increase more rapidly than their conquerors. It would puzzle one to discover any great biological advantage resulting from most European wars. People do not wage wars to promote the biological advancement of their species. They behave as if they were pawns in a game, blindly following the impulses of greed, ambition and collective pugnacity. Racial advancement may be Nature's aim, but it is not man's.

If conflict has played an important rôle in the evolution of the human species, it seems apparent that at present it has mainly outlived its biological usefulness. This does not imply that group selection is no longer operative. The racial replacement that goes on in a peaceful and generally unobtrusive manner has probably been for a long time a more potent factor in human evolution than the more spectacular but less frequent occurrence of conflict. Throughout the organic world natural selection generally works in a quiet and decorous way. Where two stocks occupy a common territory one inevitably tends to supplant the other, even though they live in most peaceful relations. The extent to which they compete as groups, however, instead of as individuals is subject to much variability. Theoretically, one may readily distinguish between individual selection, which preserves the fittest organism, from group selection, which leads to the survival of the fittest group. These two forms of selection tend to develop quite different characteristics, the one enhancing those which conduce to the preservation of the individual, the other developing characteristics making for race or group preservation, and sometimes even leading to the sacrifice of the individual life. The instincts which impel the warrior ant or termite to sacrifice itself in the defense of the colony could never have been developed by selection acting upon the individual alone. In individual selection survival depends upon the organism's own characteristics; in group selection it may depend upon the characteristics of other members of the organized society. Whether or not a queen bee survives may depend not directly upon her own peculiarities, but upon the behavior of the workers, and whether or not the workers survive may depend upon the peculiarities of the queen.

In our human relationships our chances of survival hinge in many ways upon the reactions of our fellows, but the relations of individual selection and group selection are nevertheless frequently obscure. In the first place, a human being may belong to a number of different groups at the same time. He may be a Democrat, a Baptist, an Odd Fellow and a member of the carpenters' union, and in these several capacities he will be associated with quite different individuals. To a certain extent his relation to these bodies may affect his chances of survival, his choice in marriage and the number and quality of his children. These several organizations are not, it is true, natural groups, such as the societies of ants and termites or even primitive clans of man. Nevertheless, they count for something in shaping the biological evolution of the human species. A religious sect, for instance, which attracts a certain type of adherent and instils the virtue of fecundity, may function more or less as a unit in competing with other sects and may in time have an appreciable effect upon the hereditary composition of the population. The effort to disentangle the relations of group selection and individual selection in the complex interrelationships of human society brings us into contact with many baffling problems. As a matter of fact, the struggle between different racial stocks that goes on in the peaceful concourse of social groups eventuates in neither form of selection to the exclusion of the other. In their relations to mortality and fecundity, as in many other affairs of life, people function partly in their individual capacities and partly as members of the groups to which they belong. Group membership itself is subject to frequent changes. The rivals of one period may become the allies of the next, a fact which has a profound influence upon the biological effects of racial contacts. How important this influence is may perhaps be better appreciated after we consider briefly how racial contacts are working out in various parts of the globe.

For many years following the first advent of the white man the native Polynesian and Melanesian peoples of the Pacific have shown a striking decrease in numbers. Up to within the last few years various writers have predicted the complete extinction of the native inhabitants of many islands of the Pacific area within a relatively few decades. The Tasmanians are completely gone; the inhabitants of other islands have been reduced to a small and dwindling number, the native Australians, according to the best estimates, have decreased in numbers in face of the advance of the whites. The white man has proven a deadly scourge to many peoples with whom he has come into contact. His epidemic diseases, such as tuberculosis, measles and smallpox, have decimated the ranks of several primitive peoples. His dissemination of venereal infections has seriously checked rates of natural increase. His alcoholism and other vices have contributed to his destructive influence, and his ruthless exploitation of labor and the disturbance of the sex ratio through the transportation of workers have often proven a potent factor in causing native peoples to decrease in numbers. Whenever the white race first comes into contact with primitive peoples its biological influence is usually bad. This fact is well illustrated in the contacts of Indians and whites in the history of our own country. The whites desired the lands possessed by the Indians. The Indians for the most part could not be made to work for the whites. While some trading went on to the advantage of both parties, the whites and Indians were essentially antagonistic groups, and often engaged in wars, which resulted in the replacement of the Indians by the conquering race. To a large extent the American Indian has remained outside the social organization of the whites, a member of an alien and essentially hostile group. To an even greater extent this alien status has characterized the native blacks of Australia, who have been on much the same basis as the other members of the mammalian fauna.

The issues of the contact of whites with such peoples as the American Indian and the native Australian afford a typical illustration of the working of group selection. Each group keeps largely to itself. Within each group the members aid one another in various ways, but there is little solicitude for the welfare of individuals who are outside the fold. Each group operates more or less as a whole in competition with others. As a result of competition, if not actual conflict, the group which is more advanced in culture, whether or not this implies a superior heredity, tends to prevail over and replace the less fortunate group. For the last few centuries the white race has been extraordinarily successful in the struggle for supremacy and expansion, and many native races have been wholly or in part replaced by their white rivals. The so-called yellow peril has not been nearly so portentous as the white peril has been to most peoples on the globe.

Nevertheless, in several parts of the earth the history of interracial contacts has recently passed, and in others will probably soon pass, into a different phase. In his Romanes lectures on "The Relations of the Advanced and Backward Nations of Mankind" Mr. James Bryce remarks:

> Our own time stands eminent and peculiar in this, that it marks the completion of a process by which all the races of the world have been affected and all the backward ones placed in a more or less complete dependence upon the more advanced. India, northern Asia, the Indian and Polynesian archipelagos, the Philippine Islands now own civilized masters of European stock, as do all the aboriginal races of America. Turkey, Persia, Afghanistan, Siam and, in a sense, even China, are overshadowed by European powers and prevented from passing under the control of some one or more of these only by the jealous vigilance of the others. The same forces or motives have worked to bring this result about which have induced the conquests of earlier days. But two new factors have been more active and pervasive than ever before—the desire of civilized producers of goods to secure savage or semi-civilized consumers by annexing the regions they inhabit, and the rivalry of the great civilized states, each of which has been spurred on by the fear that the others would appropriate markets which it might win for itself. The process has been much swifter than was desirable in the interests of either conqueror or conquered. But we can now see that it has become inevitable so soon as the progress of science had prodigiously increased the cheapness of both production and transportation.

This change, as Mr. Bryce points out, is giving the world a new kind of unity in which primitive peoples are taking positions analogous to those held by unskilled workers in civilized nations. The native peoples are becoming integral parts of the white man's economic order. "Such an event," Mr. Bryce remarks, "opens up a new stage in world history, a stage whose significance has perhaps been as yet scarcely realized either by the thinker or the man of action, because the historical thinker sometimes overlooks the present in his study of the past, while the man of action may be so much occupied by the present as to forget what the past has to teach him." The situation which Mr. Bryce describes is of great interest not only to students of economics and political science, but also to the biologist who is interested in the course of human evolution. It indicates a change in the course of biological development as marked as the change in the trend of political and economic history.

One of the most obvious biological effects of the extension of control over less advanced races is an increased stimulus to migration and race mixture. For long ages the evolutionary changes in the human species led to a continual divergence and redivergence into varied racial stocks. Through the effects of isolation and selection mankind has been broken up into innumerable subdivisions inhabiting different regions of the earth's surface. The geographical distribution of human races and peoples indicates that the process of speciation in man has followed much the same course that has led to the formation of races, subspecies and species among the lower animals. Whatever race fusion may have occurred was quite insufficient to counteract the evolutionary forces making for divergence during the early history of mankind. Now the course of development has been changed. The long period of divergence is being followed by a period of convergence. Peoples are mingling their blood to an extent that was unprecedented in previous history. Our greatly improved means of travel render extensive migratory movements relatively easy. Scarcely a tribe in the remotest islands of the Pacific is suffered any longer to lead a completely isolated existence. During the last few centuries the whites have not only spread into various regions of the earth and mingled their blood with native peoples, but they have caused great translocations in the populations of the countries subjected to their domination. Through their influence we find Hindus in South Africa and

Fiji, Negroes in Brazil, the West Indies and the United States, Chinese in the Philippines and Africa, and Filipinos in the United States and the various islands of the Pacific. Their development of the rich natural resources of Hawaii has caused an influx of hordes of Japanese, Portuguese, Chinese, Koreans, Filipinos, Porto Ricans, Negroes, and various other groups, forming a polychrome mass of humanity probably more diversified than the population of any other region of equal area on the face of the globe. All sorts of crosses are made in this seething cauldron of heterogeneous humanity. But this example is repeated to a less conspicuous degree in many other parts of the earth. It seems likely that with increasing trade and communication, together with the development of the relatively unutilized resources of many lands, the mingling of distinct racial stocks will go on at an accelerated pace.

The effects of white domination, in addition to accelerating race fusion, has in many parts of the world come to exert a more important influence in promoting the increase of native peoples. The unfavorable effects of contact to which we have referred may be only a temporary phase characteristic of what we may call the exploring and settling stage in the development of interracial relationships. This stage is well illustrated by the wide-spread depopulation which has been going on in Polynesia and Melanesia. But despite the predictions that many native peoples of the Pacific islands are doomed to extinction, we find that in several areas the natives are now increasing in number. The Maoris of New Zealand, who have long figured as an example of a disappearing race, have been increasing for some years. Since the beginning of the census enumerations in 1857–58 the Maoris continued to decrease up to near the beginning of the twentieth century. After this the five-year censuses have shown a slow increase of the Maoris, an apparent exception being afforded by the census of 1916, which indicated a decrease of 535 over the preceding period. This, as was explained in the census report, was due to the great war. The last five-year period showed the greatest increase of all. The half-castes, which were separately enumerated, are also increasing. The last (1931) Year Book of New Zealand states that "during the last few years the natural increase of the Maori population has exceeded that of the Europeans."

Notwithstanding the enormous hordes which have come into the Sandwich Islands, the native Hawaiians, after a long period of diminishing numbers, have recently been slowly gaining ground. The unmixed Hawaiians, however, have been decreasing, although at a diminishing rate, but if the mixed population is counted at only half its number the Hawaiians would show an increase during the past two decades. Likewise, the natives of Fiji, who have been for a long time decreasing, and who have recently had to compete with a very extensive influx of Hindus, have begun to show a small surplus of births over deaths. The downward trend of population has been turned also in the Tonga Islands, the Carolines, New Britain, the Admiralty Islands and in many smaller areas. Mr. Roberts, in his volume on "Population Problems of the Pacific," estimates that of the total island population of the Pacific area 35 per cent. is increasing, 39 per cent. is stationary, and 25.5 per cent. is decreasing, with .16 per cent. faced with an immediate prospect of extinction. These figures relate only to the endemic peoples of these islands. It is a rather striking fact that the downward trend of native population has been stayed in face of a very extensive recent invasion by peoples from Asia, especially Chinese, Japanese, Koreans and Hindus. In 1923 about two fifths of the population of Fiji consisted of Hindus, most of whom had migrated into the islands since 1900. Throughout the Pacific area there is a great demand for labor. The resources of many islands are largely undeveloped, and it may be expected, therefore, that the inpouring of Asiatics will continue and that the spectacle of Hawaii will be repeated in many islands.

If we seek an explanation for the wide-spread trends of population in the Pacific area, we can detect the influence of several causes. For the most part they may be summed up as the result of the changing relationships of native races to the dominant whites or other ruling peoples. It is coming to be realized that the native populations of the islands are a valuable economic resource which it pays to conserve. The period of forcible recruiting of labor is past. Conflicts with native peoples have practically ceased. The lawless brutality that only too often resulted in much loss of life is rapidly passing. Wise administrators are endeavoring to understand native customs and to adopt more intelligent and considerate methods of control. The natives are not only learning much from their contacts, but they are securing the advantages of hygiene and sanitation instituted by their rulers and which compensate in a measure for the deleterious effects of the diseases with which the white man has presented them. A factor of especial importance, however, is the development of the resources of the islands, which makes possible the support of a much larger population than could formerly gain a subsistence. Natives are adjusting themselves to the economic and social organization of the more advanced races. The original antagonism is gradually changing into mutual and advantageous cooperation. In short, symbiosis is succeeding hostility. Instead of being a scourge, the dominant race is a positive aid to survival. The natives are helped because they are coming to be a part of the white man's group.

Similar changes are occurring among the native peoples in other parts of the world. What statistical data we have on the native population of the Union of South Africa show an increase of the indigenous Bantu inhabitants, together with an increasing number of mixed breeds and incomers from Asia. The first effects of the invasion by whites in southern and especially central Africa were notoriously unfavorable to the increase of native peoples. Between war, the recruiting of slaves, the introduction of diseases and the demoralization of native customs, the Negroes suffered heavy losses, and in some parts white occupancy still exercises a baneful influence on the black population. As General Smuts remarks in his recent Rhodes lecture, "It is unfortunately the fact that throughout much of the African continent the native population is not increasing, and in some parts like Angola and the Congo it is definitely declining. The part of Africa in which the native population is increasing most rapidly within the last six years is the Union of South Africa, and that fact is a great tribute to the blessings of a settled European government, to the favorable economic conditions which render such an expansion possible, and to the medical care and welfare work carried on among the natives." In other parts of Africa the bad effects of the white invasion still predominate. According to a recent report on labor conditions in the Belgian Congo, the birth rate of the natives has fallen off to such an extent as to threaten the loss of man power needed in the industrial development of the region. The methods in vogue for recruiting labor are severely criticized in this report, and a plea is made for the employment of more humane and intelligent management of the Negro population in order to prevent the gradual loss of this valuable financial asset. The report is of interest in evincing a somewhat belated recognition of the value of policies which have elsewhere proven effective in conserving the supply of labor.

The British administration of India has led to a rapid growth of the native population, the last census showing an increase of some thirty million during the preceding decade. Since 1800 the indigenous population of Java has increased over tenfold under the administration of the Dutch. The Filipinos have about doubled in number since the United States came into control of the islands in 1898. The growth of the population in the West Indies is to a large extent the result of the development of the resources of these islands under the guidance of the whites. From the standpoint of racial replacement these islands have an interesting history. The inhabitants of Jamaica, Haiti, Guadalupe, Martinique and the Barbados are now mainly blacks. The ruthless exploitation of the Spaniards greatly reduced the native Indian population of these islands, and the African slaves who were imported as a substitute for the natives were more successful in adjusting themselves to the economic régime of their masters. They throve under white control and resorbed or replaced most of the natives who remained. Now the biological victory is clearly in the hands of the black man. The Caribbean has now become a great spawning area of black humanity from which numerous immigrants migrate into Mexico, Brazil, Venezuela, Colombia and Central America, where they contribute to deepen the shade of the mixed inhabitants of these countries. Several thousand have come into this country and we have at present no regular means of checking their influx.

Turning to our own race problem, we find that the trend of our Negro population is in some respects similar to that of native peoples in other parts of the globe. During the period of slavery, both master and slave profited from their association, and the Negroes multiplied at a rapid rate. After emancipation the Negroes became a more independent and, in some respects, antagonistic group. Being deprived of the care and supervision by their white masters, the Negroes came to suffer from an increased death rate, and their high birth rate began to fall. Sometime in the '80s the mortality of the Negroes began to decline, but the decrease of the birth rate caused the rate of natural increase to be reduced to such an extent that several writers have predicted that our own race problem would ultimately solve itself. Our Negro population never reached the stage of actually decreasing in numbers, but it came very nearly doing so. It has succeeded in establishing itself so that the advantages it secures apparently more than overcome the tendency of white competition to drive it to the wall. Advance returns of the latest census (1930) show that, after a period of diminishing rate of growth, our Negro population has come to increase at a more rapid rate. Between 1910 and 1920 the percentage of increase among the Negroes had fallen to 6 per cent. Between 1920 and 1930 the increase had risen to 13 per cent., or over double the rate of the previous decade. Even if, as has been maintained, many Negroes were not enumerated in the Census of 1920, it is scarcely credible that the number would be sufficient to account for the changing trend in our Negro population shown by the latest census returns.

This favorable turn in the biological fortunes of the Negro has taken place in spite of some untoward circumstances. Chief among these is northward migration, which has certainly caused at least a temporary check in the natural increase of the migrants. Up to within recent years the opinion seemed to be well grounded that the Negro could not survive in the North. Deaths exceeded births among the Northern Negroes, and the growth of the Negro population in the Northern states has therefore been due mainly to migration. The black armies which have been pouring into the North have been marching to their own destruction. The first effects of the war migration were particularly unfavorable. Families were frequently broken, marriage was often deferred, and the difficulties of establishment in the new environment created a strong temptation to limit the family among married couples. But living conditions gradually improved. Negro mortality, and especially infant mortality, decreased, and now for several years the birth rate has been rising. The Negroes bid fair to succeed in adapting themselves to a northern climate and to increase through their own birth rate. They are gradually becoming immunized to tuberculosis, and they may come to constitute a larger and larger part of the moderate standard stratum of society which contributes most plentifully to the birth supply.

The restriction of immigration has greatly stimulated the northward trek of our Negro population. Not only unskilled labor, but much of the semi-skilled and skilled labor in our Northern centers of industry is being supplied by Negro workers, as it is in South Africa. As a whole, the Negroes, especially in the North, are becoming more and more an integral part of our social and economic organization. In some respects they do not belong to our group, but in other and very important respects they do, and this fact will have an important bearing on their future biological fate. They are reaping increasing rewards from the whites, not only economically, but also in the field of hygiene and sanitation. After a period of neglect, when the Negro was treated as an outsider to whom no obligations were due, there is coming to be more solicitude for his well being. It is distinctly possible that with change of relationship to the dominant race our Negro population, like the native peoples of the Pacific islands and other parts of the world, will take on a new lease of life.

It is to be regretted that our knowledge of the vital statistics of various peoples on the globe does not permit a more accurate estimate of their relative rates of natural increase. Over large areas of the earth's surface we have only very rough estimates of the number of existing inhabitants, and we know still less of their number in times past. Certainly, the white race has increased much more rapidly than the colored races, and it is probably doing so at the present time. Nevertheless, the increase of the colored races has been to a large extent the result of the enterprise of the whites. Mr. Lothrop Stoddard's picture of the rising tide of color may not be so alarming in view of the present expansion of the white race. But if the whites are now gaining on their rivals they are scarcely justified in contemplating their future with entire complacency. Present rates of natural increase are of less importance than the kind of relations which are developing between the different races. It may well be that these relations may come to be such as to foster, much more than in the past, the increase of the relatively primitive members of a common social and economic organization. At times these relations may be symbiotic in all senses of the term. In a population of suboptimal density both a dominant and a subject race might increase more rapidly as a result of their association, but with increasing density of population this relationship changes. Although each race may contribute to the material welfare of the other, they may soon come to be rivals in reproduction in that the increase of one race will tend to check the increase of the other. And then symbiotic relationships may continue to exist between the low standard race and the employing class of the dominant race, but the relationship between the laboring populations in both races may be on a more competitive basis. Biologically, this kind of rivalry is particularly destructive to the race with higher standards of living. This fact was strikingly illustrated in the recent Mexican invasion of the Southwestern United States, where white labor was driven out of one industry after another by cheaper Indian labor from Mexico.

The fact that the interests of the employing classes are often opposed to the biological interests of their group as a whole makes the solution of many population problems a matter of great difficulty. The employing classes are politically powerful and their influence is apt to dictate the policy of the country. So long as their own welfare is enhanced by an alien element of the population, their influence will be exerted in favor of the aliens at the expense of the laborers of their own race. This same tendency is observed in the attitude of employers in South Africa, as it is in our own land. The Negro problem in South Africa is coming to be in many respects curiously like our own. Dr. J. W. Gregory, in his book on "The Menace of Colour," remarks, "The most ominous change in South Africa is the replacement of whites by blacks in many departments of work. The difference in South Africa between 1893 and 1905 which impressed me most deeply on visits in those years was the extent to which colored men had replaced white workers in many occupations. As the black man enters various branches of agricultural and industrial occupations the white man goes out." The capitalists as a rule favor the policy which gives them the cheapest labor, regardless of the future of their own stock, just as they do in this country and everywhere else. Hence, they frequently incur the not unjust reproach of constituting the most effective enemies of their own race. According to Stevens, colored and Negro artisans by 1911 were in the majority in such occupations as blacksmiths, iron founders, brick workers, stone masons, carpenters, shoemakers, tailors and harnessmakers. Naturally, the white population is feeling acutely the pressure arising from the incorporation of the blacks into their own economic group. In proportion as the Negro succeeds in industry, in that proportion does he become a menace to white labor and the supremacy of the white race.

The tendency of industrial development to cause dominant peoples to be swamped out by the descendants of more primitive stocks who are utilized as laborers is one which every wisely governed people should consider with great care. Australia and New Zealand have saved themselves, at least temporarily, from being replaced by hordes of Asiatics before it became too late. Just as bad money drives out good money, so a low standard population tends to drive out a high standard population. How many dominant stocks have invited their own destruction by the importation of aliens to do the hard work I shall not presume to state. Dominant peoples naturally desire to avail themselves of the labor of less advanced races. Where the whites are able to administer dependencies inhabited by the colored races and to profit by the trade which results from such control, they may be enabled thereby to increase their own population and welfare, at least for a considerable time. This policy of exploitation has contributed not only to the increase of the white race, but it has aided also the increase of its rivals. It has led to the formation of many kinds of groups based on relationships of mutual dependence. The material needs for the support and increase of one people may be supplied by natives in a remote quarter of the globe, so that we may have economic groups functioning more or less as units composed of natives in England, South Africa and Japan. It is largely the advantages which Japan has derived from Western culture since her former isolation that accounts for her phenomenal growth of population, which now adds about 800,000 annually to her already overcrowded area.

It is often said that the world is becoming an economic unit. Rather, it is a collection of units exhibiting various degrees of unity. Relative rates of population growth, migration, hence, the kind of racial replacement that goes on, and, hence the direction followed in biological evolution of various subdivisions of the human species, are to a large extent determined by the group relationships which develop as a result of the scramble for wealth. The student of the present evolution of our own species must concern himself not merely with the struggle between individuals or even neighboring groups, but with far reaching influences which tie together in bonds of common interest peoples of remote quarters of the globe and of most diverse racial extraction. And along with these new relationships of interdependence are developing new kinds of rivalry whose outcome can be only dimly foreseen.

In the present period of the world's history the white race, after having spread over and exploited very considerable portions of the earth's surface, and after having wrought unspeakable havoc as a result of its domination, has now come to minister to the welfare of its colored cohabitants, because it is finding them a valuable financial asset. At the same time, the whites must be credited with doing more for the less advanced races from motives of pure philanthropy. It may be financially profitable for a time to encourage population growth in alien lands. That many new kinds of competition will develop as the result of this policy seems inevitable. We have done much toward helping the meek to inherit the earth, but when they have come into a larger share of their patrimony they may not always be so meek.

SCIENTIFIC EVENTS

CONVICTIONS IN THE CALMETTE SERUM TRIAL

According to a special cable to the New York *Times,* judgment in the Calmette serum trial, which opened on October 12, was rendered on February 6. Of the four defendants Professor Max Klotz and Anna Schuetze, a nurse, were acquitted. Professor Georg Deycke was sentenced to two years in prison and Dr. Ernst Altstaedt to fifteen months for homicide and inflicting bodily injury through culpable negligence. Dr. Deycke and Dr. Altstaedt were acquitted on a count charging the same offense in the introduction of the Calmette treatment in Luebeck.

In an oral opinion Presiding Judge Wibel said that the deaths of 68 of the 76 children who died of tuberculosis in the spring of 1930 and the illness of a majority of 131 survivors who then contracted the same illness were attributable to their inoculation with virulent tuberculosis bacilli inadvertently introduced into the Calmette vaccine. While the court admitted the theoretical possibility that vaccines might revert to virulence, it held this was not practically admissible in this case. In the Luebeck Hospital laboratory Calmette cultures were prepared side by side with human tuberculosis bacilli, he said, and these two must have been accidentally confounded.

Such a mistake, the court held, was indicated by expert opinions, especially those regarding conditions in the hospital laboratory. The laboratory, while good enough for ordinary purposes, was unfit for the preparation of vaccine, and the court was convinced that the catastrophe had been caused by defects in the institution. The responsibility, therefore, rested primarily on Dr. Deycke, who as an expert bacteriologist knew the danger of a possible mistake or contamination. The precautionary instructions he had given were inadequate for certainly preventing them, the court held, the more so since, being overworked, he could not always supervise the laboratory personally.

The court held further that it had been established with a probability bordering on certainty that the catastrophe would have been averted had the vaccine been tested on animals before it was administered and that the tuberculosis outbreak would not have reached such dimensions had control through inoculation of animals been established. The responsibility for the omission was therefore held to rest also on Dr. Altstaedt, whose duty it was as chief health officer to make sure of the safety of the laboratory procedure.

Professor Albert Calmette, of Paris, the originator of the Calmette anti-tuberculosis serum, did not appear at the trial, but pleaded for the German physicians, saying that the hospital equipment was inadequate and that his colleagues should not be blamed. The serum was provided from the Pasteur Institute in Paris in July, 1929.

THE INTERNATIONAL SCIENTIFIC EXPEDITION

THE Department of the Navy has issued a statement to the effect that the *U. S. S. S-48* and the *U. S. S. Chewink*, naval ships on board which scientists of the International Scientific Expedition will cruise for two months while measuring ocean depths and the pull of gravity in the vicinity of the West Indies and the Bahamas, sailed on Sunday, February 7, from Guantanamo Bay on the first loop of their cruise.

The part of this first loop to be covered by the two ships lies southward of the Island of Jamaica and around the west end of Cuba, including 18 gravity stations, cruising about 1,125 miles and ending at Key West on February 11. There, computation of recorded data and a check-up with shore gravity stations were undertaken, after which the two ships left on the second portion of this loop, extending up the Florida Straits and the Old Bahama Channel.

Investigators embarked in the *S-48* and the *Chewink* are Dr. F. Vening Meinesz, member of the Geodetic Commission of the Netherlands; Mr. Harry Hess, proctor fellow in geology at Princeton University, and Mr. Townsend Brown, of the United States Naval Research Laboratory. Lieutenant Commander Allen H. Gosnell, U. S. Naval Reserve, is accompanying this unit of the International Scientific Expedition in the capacity of historian.

Professor Richard M. Field, director of the expedition, has sailed from Miami for study of the structural geology of the outer Bahamas, this study to be supplemental to the gravimetric survey being made beneath the sea by Dr. Meinesz.

In commenting in his dispatch on preparations made since the Meinesz unit of the expedition sailed on January 27 from Norfolk on board the *U. S. S. Tarbell*, destroyer, Lieutenant Commander Gosnell reports as follows:

> Set up gravity apparatus on deck of *Tarbell* in lee of Crooked Island January 29. Dr. Meinesz, Hess and Brown in Santiago during earthquake of February 3. Escaped safely from hotel and spent remainder of night on bench in Plaza. *S-48* and *Chewink* arrived at Guantanamo February 4. Commenced work on iron framework for apparatus.
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> On February 5, ships successively at sea testing all depth-finding installations. February 6, charging batteries and completing preparations for test of all gravity apparatus. This test in progress February 7 alongside dock. Prior to arrival of ships, party was engaged in working up results of tests made at Naval Research Laboratory.

SCIENTIFIC PROBLEMS OF THE ARCTIC

THE United States has been slow about joining the other nations in plans for studying scientific problems in the colder regions of the earth during August, 1932, to August, 1933, but Science Service reports that it will probably take part and establish a station at Fairbanks, Alaska. All that is needed is the money —$30,000—and the Senate Foreign Relations Committee has reported out the bill authorizing this expenditure. It is expected to pass, despite the depression, and the economy program of the administration. Recommendations in its favor were made to the committee both by President Hoover and Secretary of State Stimson.

Twenty-six nations have arranged to take part in this "Second Polar Year Program." The United States will make the number twenty-seven. Subjects to be studied are the magnetism of the earth; the aurora or polar lights; the natural electric currents which flow in the earth's crust; the electric condition of the atmosphere; the relation of radio transmission and reception to all these phenomena and to the condition of the surface of the sun, also meteorological conditions to great heights in the atmosphere.

The Senate committee in making its favorable report for authorizing the $30,000 expenditure said:

> It must not be forgotten that this polar year program has by now become irrevocable, except in the event of direct calamity. Too many nations have already made extensive preparations for the work to permit its being dropped except under very special circumstances. There is at present not the slightest prospect that it will be dropped. The present plan is that the United States of America shall provide funds for a polar-year station at Fairbanks, Alaska. The request for $30,000 has been made with full realization that adverse economic conditions demand that the amount shall represent the irreducible minimum for carrying on the work at that station.
>
> Fairbanks, Alaska, occupies a key position in the distribution of polar-year stations. There are no other stations near-by—in fact, unless Fairbanks is occupied as a station, about one fourth of the Arctic region will be totally neglected. . . . Economically we are probably not worse off than are other nations that are participating.

COMMITTEE ON NOISE MEASUREMENT OF THE AMERICAN STANDARDS ASSOCIATION

THE organization of a sectional committee on noise measurement under the procedure of the American Standards Association was recommended by a general conference of 32 representatives of 18 national bodies held in New York on January 29. It was also recommended that the committee function under the technical leadership of the Acoustical Society of America.

The scope of the project as recommended by a steering committee consisting of Professor Vern O. Knudsen, Acoustical Society of America; E. E. Free, American Society of Mechanical Engineers; P. L. Alger, American Institute of Electrical Engineers; H. R. Summerhayes, National Electrical Manufacturers Association; R. G. McCurdy, ASA Telephone Group; and Dr. Harvey Fletcher, Acoustical Society of America, is the "Preparation of general standards of nomenclature, units, scales and measurement in the field of acoustics, with special reference to noise measurements."

The conference followed a request made by the Acoustical Society of America to the American Standards Association to set up a national committee to correlate the activities of various technical and trade organizations which have been attempting individually to set up standards for noise measurement. Eight such organizations now have committees on this subject. It was pointed out that the diverse nomenclature and methods of measurement growing out of these uncorrelated activities were interfering with the progress of scientific work on the subject and that without real national standardization this condition would become worse as different individuals became accustomed to different concepts and terms.

For the present the committee's work will be concentrated chiefly on the standardization of nomenclature, units and scales. It is believed that further progress in the science of noise measurement is necessary before effective standardization of this phase of the subject can be completed. There is some confusion in the measurement of noise at the present time because of the complex nature of noises and their effect upon the ear, and the fact that none of the noise meters yet designed can translate the approximate physiological and psychological effects of noise into definite units of measurement. Dr. Harvey Fletcher, of the Bell Telephone Laboratories, pointed out at the conference that to the average individual a noise composed of widely separated frequencies is less disturbing than a noise of equal intensity, but having components close together in the frequency range.

SUPPORT FOR BIOLOGICAL ABSTRACTS

DURING the year 1931 the following sums have been contributed to *Biological Abstracts* and to the Union of American Biological Societies in support of this publication:

To the Union of American Biological Societies	
American Association for the Advancement of Science	$ 400.00
American Association of Anatomists	100.00
American Physiological Society	125.00
American Society of Biological Chemists	100.00
American Society for Experimental Pathology	50.00
American Society of Naturalists	50.00
American Society for Pharmacology and Experimental Therapeutics	50.00
American Society of Zoologists	200.00
Botanical Society of America	150.00
National Research Council	1,500.00
Society of American Foresters	50.00
Contributions by individuals	55.00
Total	$2,830.00
To *Biological Abstracts* directly	
American Society of Naturalists	$ 50.00
American Society of Zoologists	500.00
Total	$550.00

An accounting for expenditures under these sums, as received to December 15, 1931, was made by the treasurer of the union at the meeting of the council of the union in New Orleans on December 28. The results of the solicitation of subscriptions in recent months have thus far led to cash receipts to *Biological Abstracts* that exceed by several hundred dollars all the funds expended during 1931. This is comparable to turning over cash to the *Abstracts* in excess of all money contributed by the societies and in addition financing all activities of the union on behalf of the *Abstracts*. Moreover, the newly acquired subscriptions are likely to be continued in subsequent years, and the activities of the union have been given publicity that should have a continuing value.

In addition to the contributions listed, the American Society of Zoologists passed the following motion by unanimous vote of the forty-five members in attendance at the business meeting held in New Orleans December 30, 1931:

> It is moved, subject to approval by two thirds of the members voting in a mail ballot to be sent out by January 10 and returned by February 1, 1932:
>
> (1) That the annual dues be advanced to $5.00 of which $3.00 shall be paid by the Treasurer to *Biological Abstracts* with the proviso that any member or associate member subscribing to this publication shall have this $3.00 credited upon his subscription.
>
> (2) That for the year 1932 and for any later years the Executive Committee be authorized to reduce this addition to the dues by such amounts paid from funds then in the treasury as may be possible without undue reduction of the balance desirable for current activities of the society.

The returns from this mail ballot among life and active members are: 256 for the motion; 60 against. Ballots were also sent to the associate members, who pay the same dues as the full members of this society but have no votes, in order that their sentiment might be recorded. The returns from this vote by associate members are: 48 for the motion; 8 against.

In addition to the substantial amount involved, this action by the zoologists is important because it points the way for societies to support the *Abstracts* even though there may be no immediate prospect of making full subscription a condition of membership.

W. C. Curtis,
President of the Union of American Biological Societies

SCIENTIFIC NOTES AND NEWS

On the occasion of his sixtieth birthday anniversary on February 5 Dr. Lafayette B. Mendel, professor of physiological chemistry at Yale University, was presented with a portrait of himself painted by John Quincy Adams, the Viennese artist. Over four hundred students and associates participated in making the gift "in recognition of Professor Mendel's long and distinguished service as a teacher and as a leader in his field of science."

Dr. John M. T. Finney, professor of clinical surgery at the Johns Hopkins University, received on February 1 the Bigelow medal of the Boston Surgical Society. At the meeting when the presentation was made he spoke on "Changing Methods of Surgery."

The faculties of Northwestern University gave a dinner on February 19 in honor of their colleagues who had taught in the university for twenty-five years. These included Dr. Thomas F. Holgate, professor of mathematics and dean emeritus of the College of Liberal Arts. Dr. Holgate was acting president of the university from 1904 to 1906 and from 1916 to 1919.

Dr. W. B. Mercier, director emeritus of the agricultural extension division of the Louisiana State University, was awarded the distinguished service ruby of Epsilon Sigma Phi, honorary agricultural extension fraternity, at a recent meeting in Chicago. Only three others have received this honor, which is given in recognition of meritorious service to agriculture.

At the recent elections of the Société de Biologie of Paris, Dr. A. F. Blakeslee, of the Department of Genetics of the Carnegie Institution of Washington, was made an associate, having previously been a corresponding member of the society.

The Duddell Medal of the Physical Society of London has been awarded to Professor C. T. R. Wilson, Jacksonian professor of natural philosophy in the University of Cambridge.

Dr. David Hilbert, professor of mathematics at Göttingen, celebrated his seventieth birthday on January 23. Dr. Carl Duisberg, professor of chemistry, celebrated on January 21 the fiftieth anniversary of his doctorate.

Dr. L. H. Adams, of the Geophysical Laboratory of the Carnegie Institution, has been elected president of the Washington Academy of Sciences. Dr. W. S. Eichelberger, director of the Nautical Almanac Office of the U. S. Naval Observatory, and Dr. W. H. Wilmer, director of the Wilmer Institute of Ophthalmology of the Johns Hopkins University, have been elected non-resident vice-presidents.

At the thirty-ninth annual meeting of the Geological Society of Washington, Dr. François E. Matthes, of the U. S. Geological Survey, was elected president.

AT the annual meeting of the Southern Division of the American Phytopathological Society at New Orleans, Dr. L. E. Miles was elected to represent the division on the council of the society, and an executive council for the division was elected consisting of Dr. R. F. Poole, Dr. C. D. Sherbakoff, Dr. Miles and Dr. W. N. Ezekiel. At a subsequent meeting of this council, Dr. Poole was designated as chairman and Dr. Sherbakoff as secretary.

MR. FRANCIS P. GARVAN, president of the Chemical Foundation, was elected president of the U. S. Institute for Textile Research, at a recent meeting of the directors. Mr. Garvan succeeds the late Dr. Samuel W. Stratton, formerly president of the Massachusetts Institute of Technology, who had been the first president of the institute.

DR. CONRAD BECK, director of R. and J. Beck, Limited, scientific instrument manufacturers, has been elected president of the Royal Microscopical Society; Mr. A. Earland, Dr. R. Ruggles Gates, Mr. J. Reinberg and Dr. G. S. Sansom have been elected vice-presidents.

THE title of professor of biochemistry has been conferred on Dr. Robert Robinson, of the Lister Institute of Preventive Medicine, and that of reader in biochemistry on Dr. J. M. Gulland, also of the institute, and on Dr. William Robson, of King's College.

THE following appointments have been made at the University of Sheffield: Mr. B. H. Bentley, at present lecturer in botany, as professor of botany; Dr. R. N. Rudmose Brown, at present lecturer in geography, as professor of geography; Mr. L. E. S. Easthem, as professor of zoology; Dr. J. Florey, as professor of pathology, and Dr. J. W. Edington, as professor of bacteriology.

MR. ANDREW THOMSON, previously aerologist for the Meteorological Service of New Zealand and for some years director of the Apia Observatory, has been appointed meteorologist in the Canadian Meteorological Service.

DR. A. B. STOUT, director of the laboratories of the New York Botanical Garden, is spending February and March in southern Florida in further studies of flower behavior and fruit production of avocados.

LEAVE of absence from the University of Michigan has been granted to Dr. Warren Weaver, professor of mathematics; F. P. Woy, professor of engineering administration, and Dr. Gordon Ritchie, assistant professor of pathology.

DR. GEORGE C. SHATTUCK, assistant professor of tropical medicine at the Harvard Medical School, sailed from New York on January 23 for Pt. Barrios, Guatemala, where he will undertake research work under the auspices of the Carnegie Institution. Accompanying Dr. Shattuck is Dr. John L. Bremer, Hersey professor of anatomy. The party will explore also the Mayan ruins in northern Guatemala.

DR. J. W. GREGORY, professor of geology in Glasgow University, has arrived in Lima, Peru, at the head of a scientific expedition to study geological formations of the mid-Andean range. The expedition will continue from Peruvian territory into Bolivia and Chile.

PROFESSOR H. J. MULLER, of the University of Texas, delivered two addresses at the Johns Hopkins University on February 8. He spoke before the genetics seminar of the department of zoology on "Mutation, Positive and Negative" and at the Johns Hopkins Hospital on "X-ray Mutations in Relation to Medicine."

DR. E. V. MCCOLLUM, of the Johns Hopkins University School of Hygiene, lectured on January 15 before the North Carolina section of the American Chemical Society, on "The Chemical Background of the Science of Nutrition."

DR. THOMAS S. CULLEN, professor of gynecology at the Johns Hopkins Medical School, delivered the Phi Beta Pi Lecture at the Vanderbilt University School of Medicine on February 16. His subject was "Gynecology of Yesterday and of To-day."

DR. ALBERT EINSTEIN gave a lecture on "The Geometric Interpretation of the Gravitational and Electric Field" at the University of California at Los Angeles, on February 15. Dr. Einstein spoke in German, and his address was translated by Dr. Richard Chase Tolman, professor of physical chemistry and mathematical physics, of the California Institute of Technology.

THE annual public Darwin Anniversary Address, under the auspices of the Botanical Seminar of Michigan State College at East Lansing, was given on February 12 by Professor Charles E. Allen, head of the department of botany of the University of Wisconsin.

THE Non-Resident Lectureship in Chemistry at Cornell University was established by Mr. George Fisher Baker in 1925. Up to the present time the lecturers under this plan have come from abroad, each of them remaining at the university for a full term. It is now planned to expand the program by inviting leading chemists of this country to give one or two lectures before the department on the Baker Foundation. Lecturers and their subjects for the coming university term are as follows: March 7, Professor

Roger Adams, University of Illinois, "Stereochemistry of Substituted Diphenyls"; March 22 and 23, Dean S. C. Lind, University of Minnesota, "Chemical Action under Alpha Radiation" and "Chemical Action in Electrical Discharges"; April 19, Mr. George W. Morey, Geophysical Laboratory, Carnegie Institution, "Transport of Material through a Vapor Phase"; May 2 and 3, Professor R. A. Gortner, University of Minnesota, "Biochemistry and the World To-day" and "The Electrical Value of Forces at Interfaces," and May 17, Mr. R. S. Wilson, Standard Oil Company, Chicago, "The Mechanics of Lubrication."

DR. E. MOLES, general secretary of the Ninth International Congress of Pure and Applied Chemistry, which was to have been held at Madrid, April 3–10, writes as follows: "We have the honor to inform you that the Bureau of the International Union of Chemistry has met with the Delegates of the Organizing Committee specially invited to this meeting, Professor Biilmann acting as president. They considered with care the situation produced all over the world by the economic crisis. If our congress has to be held under such unfavorable circumstances it would necessarily be limited in its efficacy. Subsequently the bureau resolved by common consent with the Organizing Committee to postpone the Ninth International Congress of Chemistry until happier times, that we eagerly hope will arrive quickly. In any case the postponement will affect at least the whole year of 1932. Madrid will be kept as the place of meeting of the next congress. You collaborated very kindly in announcing the congress. Would you be kind enough now to publish the postponement?"

THE American Association of Physical Anthropologists will hold its annual meeting at the Smithsonian Institution, Washington, D. C., on March 21, 22 and 23.

THE Graduate School of Tropical Agriculture at the University of Hawaii announces four graduate research fellowships: two in chemistry in the Experiment Station of the Hawaiian Sugar Planters Association and two in entomology in the Experiment Station of the Association of Hawaiian Pineapple Canners. The stipend of the fellowships is $1,500 for the year 1932–33. Fellows are eligible for reappointment the second year.

THE annual meeting of the committee on the C. M. Warren Fund for Chemical Research of the American Academy of Arts and Sciences will be held in May, 1932. Applications for grants not exceeding $500 in amount should be in the hands of the chairman, Professor James F. Norris, Massachusetts Institute of Technology, Cambridge, Massachusetts, not later than April 1. Applicants should submit a statement of the significance and plan of the proposed research, and the manner in which the money requested is to be used.

The Experiment Station Record reports that a citrus laboratory is to be erected by the Bureau of Chemistry and Soils of the U. S. Department of Agriculture on the grounds of the substation at Weslaco, Texas, in the Rio Grande Valley, for the study of citrus fruit culls and their by-products. A building for this work is to be erected by the chambers of commerce of Weslaco and Mercedes. The first year's program will center largely around problems of grapefruit utilization, including the stage of maturity most favorable for preservation, the utilization of waste from canneries and juice factories, and the feasibility of preparing grapefruit oil, pectin, naringin and other valuable constituents from oil and waste material.

THE London *Times* reports that a British expedition is being formed under the leadership of Mr. Frank Smythe which, subject to permission from the political authorities, will this year attempt to climb Nanga Parbat, in Kashmir, the highest peak in the Western Himalaya. Nanga Parbat stands 26,629 feet high. It is the sixth or seventh highest peak in the world. It was visited in 1895 by a party consisting of A. F. Mummery, General (then Major) Bruce, Professor Norman Collie and Geoffrey Hastings. Mummery made an attempt to climb it accompanied by a single Gurkha, and got to 20,000 feet. Subsequently Mummery, with two Gurkhas, left the base camp to cross the Diamir Pass. They disappeared, and no trace of them was ever discovered. The new British expedition will go prepared for a three months' "siege." It is thought that the knowledge gained in recent British and German expeditions to Kamet and Kanchenjunga may be of use. Mr. Smythe was the leader of the small party which last year conquered Kamet, and a member of the Dyhrenfurth Expedition which attempted Kanchenjunga the previous year.

ACCORDING to the *Journal* of the American Medical Association the new Edward Mallinckrodt Institute of Radiology, at Washington University School of Medicine, St. Louis, representing an investment of $1,220,000, is now in almost complete clinical operation. The eight-story building houses the roentgenologic activities of the school of medicine and the allied hospitals. The second, third and fourth floors are reserved for general roentgenologic, surgical urologic and gastro-intestinal diagnoses; the waiting rooms have been planned to eliminate confusion in separating hospital and dispensary cases and making further division of patients by sex and race. The time necessary for a diagnosis has been shortened by having dark rooms on each of these floors, all the chemicals for which are mixed in central tanks on the fifth floor and fed to the individual dark rooms below through specially constructed pipes. The fifth floor has been set aside for treatment work, the sixth for research in the physics of radiation, and the seventh for roentgen research on animals, but these are not yet in use. Since treatments comprise less than 5 per cent. of the work done at the institute, they are now being given in smaller quarters in the basement. The institute was erected under the direction of Dr. Sherwood Moore with funds provided by the late Edward Mallinckrodt, Sr., and Mr. Edward Mallinckrodt, Jr. Special apparatus, worth $20,000, was provided by John F. Queeny and his son, Edgar M. Queeny, and the General Education Board gave the endowment of $750,000. A memorial room is planned on the main floor of the institute for Dr. R. Walter Mills, who, as director of the department of radiology, planned the development of the institute. Dr. Mills died in 1924 from over-exposure to x-rays. Since his death, the project has been carried on by Drs. Moore, Evarts A. Graham and W. McKim Marriott, dean of the medical school.

According to the *Journal* of the American Medical Association the Henry Barton Jacobs collection of medical books, prints, medals and autograph letters was formally presented to the Institute of the History of Medicine of the Johns Hopkins University, on January 14, by Dr. Henry Barton Jacobs. What is believed to be the world's only complete collection of the writings of Réné-Théophile-Hyacinthe Laënnec (1781–1826) is included in the gift. Included also are complete collections in all editions and all western languages of the writings of Edward Jenner (1749–1823), Louis Pasteur (1822–1895) and Sir William Osler (1849–1919). The collection consists of 5,000 volumes, about 2,500 medical prints, 500 medical medals and about 300 autograph medical letters and manuscripts. Stained glass windows commemorating Laënnec, Jenner, Pasteur and Osler have been placed in the room which Dr. Jacobs has equipped on the institute floor of the library for housing the collection as a unit. Dates, medical symbols and works associated with the men they commemorate are worked into the design of the windows. The collection was accepted on behalf of the university by Mr. Daniel Willard, president of the board of trustees; President Joseph S. Ames presided. The speakers included Dr. William H. Welch, Dr. Harvey Cushing, Colonel Fielding H. Garrison and Dr. Jacobs. Dr. Jacobs was recently elected president of the Friends of the Johns Hopkins University Library.

It was announced a few months ago that the International Institute of African Languages and Cultures had received from the Rockefeller Foundation a substantial grant for the development of sociological research in Africa. The London *Times* now reports that the council of the institute, after consultation with anthropologists in several countries and with African administrators and educators, has decided that the best use that can be made of the resources at its disposal is to encourage and assist studies directed to a single main objective. It has selected as this objective the problem of the cohesion of African society. Native society in Africa is subjected to a severe strain through contact with the ideas and economic forces of European civilization. The object of the proposed study will be to obtain a better knowledge of the bonds which hold African society together and unite its members in a common discipline and mutual loyalty, of the ways in which these bonds are being modified or destroyed by the new forces that are invading the continent, and of the new social groupings which are replacing those that are unable to survive in the changed conditions.

Nutrition Abstracts and Reviews, a new periodical dealing comprehensively with the nutrition of man and the lower animals, has just been issued under the direction of the Imperial Agricultural Bureaux Council, the Medical Research Council, and the Reid Library, Aberdeen, Scotland. Its editorial staff, headed by John Boyd Orr, is assisted by corresponding editors in twenty-nine other countries. The corresponding editors in the United States are Dr. H. C. Sherman, Columbia University, and Dr. J. R. Mohler, chief of the Bureau of Animal Industry, U. S. Department of Agriculture. *Nutrition Abstracts and Reviews* contains editorial comment and brief articles by leading authorities, but consists principally of abstracts classified in six main sections for the convenience of workers in various fields. The abstracts present scientific findings reported in about 450 periodicals. A short book-review section concludes the volume, the first of which contains 351 pages and covers the period January 1 to June 30, 1931.

A library of British Empire films has been formed by the Empire Marketing Board and the first catalogue, containing the names of over 130 films, has been issued. Schools in all parts of the country are now receiving regularly short films of life and work oversea. These have been catalogued under countries, and practically every school in the United Kingdom will receive a catalogue. Mr. John Grierson, the board's film officer, recently visited Canada and brought back much material from the Canadian Government Motion Picture Bureau. There is now a particularly good selection of Canadian films, ranging from pictures of production—the felling of lumber, harvesting of apples and catching of salmon—to fighting forest fires with seaplanes, camping in the Rockies and other aspects of life in the Empire. Films of how people live and how the Empire's food is raised in other Dominions and in several of the Colonies are included in the catalogue. Over 2,000,000 people, of whom about half were school children, have now attended the Imperial Institute cinema at Kensington, where the Empire Marketing Board films are shown continuously. One of these pictures is described as a "dramatized lesson in economic history," and shows, in a series of swift, vivid flashes, the development of the North American prairies. Another is a one-reel version of *Drifters,* a film epic of the North Sea.

FORTY of the states and territories will spend a total of $201,917 for growing and distributing trees for planting of farm forests in 1932, according to budget figures received by A. B. Hastings, chief of state cooperation in the forest service. The federal government will allot $73,288 to these states under the cooperative farm-forest planting clause of the Clarke-McNary Act. The cooperating states have budgeted $645,298 for various forest-tree production and distribution purposes for the fiscal year 1932, which is only about $5,000 less than the 1931 total. About 31 per cent. of the total state funds will be used for farm-forest planting arrangements in which the federal government is cooperating. In addition to the $73,288 in federal allotments for 1932, $3,150 is to be available for administrative purposes and $18,561 as a contingent fund for allotments to new states entering the cooperative arrangements, making a total federal budget of $95,000 for aid in farm forestation. With the 1931 state and federal funds the states furnished approximately 25,000,000 trees for planting in farm forests. Comparatively large increases in cooperative state funds devoted to farm-forest planting projects were budgeted in New Jersey, Indiana, Florida, Nebraska, Louisiana, Oklahoma, Pennsylvania and South Carolina, with lesser increases in Delaware, Maryland, Washington, Michigan and Wisconsin.

DISCUSSION

ASYMMETRIC VALLEYS AND CLIMATIC BOUNDARIES

IN a recent article in SCIENCE[1] Russell discusses the coincidence of position of the January isotherm of 32° F. with certain asymmetric valleys having the steeper slopes facing north. The writers believe that Russell is correct in emphasizing climatic conditions as a cause for asymmetry and in considering the freezing of soil water as of great importance. They doubt, however, that he has established any association between a given type of asymmetry and any isothermal line.

In enumerating the causes of asymmetry, Russell neglected to mention the factor of stream deflection due to the earth's rotation. This factor was given more consideration by Gilbert and his contemporaries than is now customary. However, before climatic generalizations are established, asymmetric valleys attributed to this cause must be satisfactorily eliminated. One of the best known examples lies on the January isotherm of 32° F. and one lies far south.

Fuller,[2] in regard to asymmetric valleys of southern Long Island, declares that a full four fifths of these valleys have a steeper western slope. In his opinion, the deflection hypothesis of the early workers is the best explanation available. On Martha's Vineyard are similar valleys to which the same argument is applicable. Thus we have, directly under the isothermal line in question, examples of an asymmetry apparently unrelated to climatic conditions.

The marked asymmetry of the valleys of the coastal plain of North and South Carolina is characterized by steeper, north-facing slopes. These valleys lie several hundred miles south of Russell's line and nearer the January isotherm of 40° F. According to Kerr,[3] these valleys are due to right-hand deflection of streams.

The detailed, irregular, isothermal line on Russell's maps[4] appears to cross the Pajarito Plateau of New Mexico, described by Henderson.[5] Here are asymmetric valleys with the steeper slope facing the south. A comparison of Henderson's description with Culbertson's[6] description of the wooded, asymmetric valleys of southern Indiana brings out clearly how—along the same (January, 32° F.) isothermal line—the same processes may produce diametrically opposite results in arid and in humid climates.

Asymmetry is not uncommon in arid regions and has been observed by Bryan at many localities in southern Arizona. Generally the south side of the valley has the gentler slope and is marked by heavier vegetation. The interrelation seems obvious: shelter from the sun's rays decreases soil evaporation and transpiration; consequently plants thrive and in turn protect the slope from the violent erosive action which makes the north slope bare and steep.

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[1] R. J. Russell, "Geomorphological Evidence of a Climatic Boundary," SCIENCE, 74: 484–495, 1931.

[2] M. L. Fuller, "Geology of Long Island," Prof. Paper 82: 50, 1914.

[3] W. C. Kerr, "Topography as Affected by Rotation of the Earth," *Proc. Am. Phil. Soc.*, 13: 190–192, 1873.

[4] R. J. Russell, "Dry Climates of the United States: I, Climatic Map," *Univ. Calif. Publ. Geog.*, 5: 1–41, 1931.

[5] E. L. Hewett, J. Henderson, W. W. Robbins, "Physiography of the Rio Grande Valley, N. M., etc.," *Bull. Bur. Amer. Ethnol.*, 54: 1913.

[6] G. Culbertson, "Some Evidence Indicating the Importance of Frost Action in Widening Valleys," *Proc. Ind. Acad. Sci.*, 1899: 167–170, 1900.

It seems that Russell's idea of a correlation between frost action and some one isotherm has merit. Frost action is doubtless of great importance in the asymmetry of valleys in humid lands, though perhaps of less importance in arid regions.

In the North America Continent nearly all the area north of the isotherm of 32° is glaciated and only post-glacial valleys can show asymmetry. Many of these are, however, too youthful. It may be that all the humid area north of the isotherm where frost action is prevalent would in turn develop asymmetry. Obviously the nearly unglaciated northern portion of Asia is the region for testing this question. Asymmetry in the valleys of the northward flowing rivers of Siberia has already been reported and attributed to right-hand deflection. The characteristic of smaller valleys, so far inadequately described, would appear to be critical.

KIRK BRYAN
SHIRLEY L. MASON

HARVARD UNIVERSITY

METEORIC DUST

SCIENCE NEWS, in SCIENCE for January 22, contains an article on "Meteoric Dust," to one paragraph of which I feel bound to take exception.

It is not a fact that I have been collecting meteoric dust "over a period of thirty years." Of course, meteoric dust, like rain, falls alike on the just and the unjust; but that is not scientific collecting.

It is true that certain samples of dust, from roofs, towers, flues and locomotive smoke boxes, have been examined by me, using quite simple, even crude apparatus. In the outdoor dusts there were found both magnetic globules and glassy globules. Flues of anthracite furnaces show occasional magnetic globules, and the dust from locomotive smoke boxes contains them in large proportion, whence I take it that locomotives are efficient, if not sufficient, producers of the magnetic globules in atmospheric dust.

The glassy globules appear in dusts from house roofs and towers; *e. g.*, in deposits on the flat roof of Building C, Harvard College Observatory, where they are in the winnowings of thirty years; in dust from a house roof in Chippewa Falls, Wisconsin; and in the dust on the upper platforms of the Pilgrim Memorial Tower, Provincetown, Massachusetts.

Such globules were reported by Thoulet in 1908 as existing in the dust from towers of the cathedral in Nancy, France. I do not find them in anthracite flues or in locomotive dusts. But I have not examined dusts from glass works or from mineral wool factories; and the samples from locomotives have been too few for generalization. Some well-equipped mineralogist might pursue the subject to advantage.

Until some one discovers a criterion for the identification of meteoric dust, the only course is the exclusion of alternatives. This exclusion seems to be satisfactory in three cases: the sample from the ship *Joshua Bates*, studied by Ehrenberg, the magnetic globules of Murray and Renard, found in the "red clay" deposits of the deepest seas, and the sample collected on November 16 and 17, 1897, in Dublin, Ireland, and analyzed spectroscopically by Hartley and Ramage.

Thoulet was probably hasty in assigning a cosmic origin to the Nancy globules; and a considerable search for alternatives is necessary before calling the glassy globules which I have found meteoric or cosmic.

WILLARD J. FISHER

HARVARD COLLEGE OBSERVATORY

THE OESTRUS-PRODUCING HORMONES

THE recent note by Marrian and Butenandt[1] contains several statements which can hardly be substantiated if one refers to our original papers. Our first paper[2] on theelol appeared in the October issue of the 1930–31 *Proceedings* of the Society of Experimental Biology and Medicine and Marrian's[3] paper was received by us on October 28, 1930. We characterized the triol as an unsaturated trihydroxy compound having a formula $C_{18}H_{24}O_3$ and a melting-point of 273° C. The tri-acetyl derivative had a melting-point of 126° C. In a later paper,[4] the one about which Marrian and Butenandt complain, Marrian's data are compared with ours in adjacent columns of Table I and some discussion is given in the text. The table contains Marrian's carbon and hydrogen analysis, the molecular weight, melting-point, formula and the fact that Marrian found 3 hydroxyls per molecule. In the text we expressed the belief that Marrian might have an isomeric triol or an impure triol and that, if the latter were true, the contaminating substance might be theelin.

It is also stated that we have ignored the evidence of Marrian's analytical data. We doubt whether carbon and hydrogen analyses would detect the presence of amounts of theelin ($C_{18}H_{22}O_2$) up to 10 per cent in otherwise pure theelol ($C_{18}H_{24}O_3$), whereas the melting-point would certainly reveal the presence of the impurity. In our preparations we have frequently obtained about ten times as much theelol as theelin.

The complaint that Butenandt's conversion of $C_{18}H_{24}O_3$ to $C_{18}H_{22}O_2$ has not been properly recognized likewise seems to have little foundation. To be sure, the passage in which the conversion is mentioned appears in an unusual place, but it is the unusual rather than the commonplace that attracts attention. An addendum to our paper contains the reference to his experiments.

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[1] G. F. Marrian and A. Butenandt, SCIENCE, 74, 547, 1931.

[2] E. A. Doisy, *et al.*, *Proc. Soc. Expt. Biol. and Med.* 28, 88, 1930.

[3] G. F. Marrian, *Biochem. J.*, 24, 1021, 1930.

[4] S. A. Thayer, L. Levin and E. A. Doisy, *J. Biol. Chem.*, 91, 655, 1931; E. A. Doisy and S. A. Thayer, *J. Biol. Chem.*, 91, 641, 1931.

Since this note is a presentation of our views on points raised by Marrian and Butenandt perhaps we may be accorded the privilege of commenting upon another phase of the matter.

At times we are mildly annoyed by the statements that are attributed to us by others writing on the follicular hormone. For example, both Laqueur[5] and Butenandt[6] state that we found a potency of 8,000,000 mouse units per gram of theelin. Actually, we have reported from 2,500–4,000 *rat units* per milligram and each investigator has converted these figures to mouse units, using such conversion factor as seemed most probable to him. Recently, we have for the first time assayed our crystalline theelin according to Butenandt's procedure (a single injection of a solution in sesame oil) and obtained a value much greater than 8,000,000 mouse units per gram.

As another example, both Marrian[3] and Butenandt[7] have stated that we gave to theelin the formula $C_{18}H_{23}O_2$, whereas what we actually stated in a brief preliminary note was: "Average, C 79.69 per cent; H 8.49 per cent; O 11.82 per cent. These data give an empirical formula of $C_{18}H_{23}O_2$ with a molecular weight of 271, which corresponds with the data of the table." Any organic chemist would know that either $C_{18}H_{22}O_2$ or $C_{18}H_{24}O_2$ is possible and more probable. Apparently the data were not recalculated or the wording of our statement would have been more apparent. Such corrections might be made *ad infinitum* if we allow our grievances to annoy us.

We have been both amazed and pleased with the investigations which seemed to have hinged at least in part upon the introduction of the vaginal smear bioassay procedure.[8] Others being interested in the same general problem increases one's interest in his own work, and it has been a source of extreme gratification that so many investigators have become interested in the "ovarian hormone" problem.

The interests of the workers of this laboratory have been mainly chemical and we have endeavored to contribute our bit, at the same time recognizing the contributions of others. If the outstanding results of Marrian and Butenandt have not been adequately recognized in our previous papers, we are sincerely regretful, since it is farthest from our desire to attain recognition by detracting from the works of others.

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STALACTITES AND STALAGMITES GROWING ABOVE GROUND

An interesting occurrence of stalactities and stalagmites forming above ground has been noted by the writer. More than three hundred stalactites and a number of stalagmites, in all stages of development, are growing from the roof of a railroad bridge in the city of Wooster, Ohio.

The rain water which falls upon the bridge percolates through four feet of limestone ballast and a foot of cement before it finds its way through the joints between the steel plates to the ground below The largest stalactite is twelve and one half inches long and about one half inch in diameter. There are many others more than six inches in length.

During the summer of 1919 the bridge was cleaned and painted. The stalactites are, therefore, not more than twelve years old. Where the water has dripped on the steel girders below a number of stalagmites have formed. Several of these are from an inch and one half to two and one half inches long. The solution is of high concentration and the rate of evaporation is high; consequently the stalactites are growing rapidly. Their great number affords an excellent opportunity to study them in all stages of development. In the near future the writer expects to publish the results of his observations.

Karl Ver Steeg

College of Wooster

ENTOPTIC COLORS

The entoptic colors described by Elmer F. Way as occurring during the operation of a motion picture projector at reduced speed, may perhaps be an instance of the phenomenon known as Fechner's colors. If a disk, partly black and partly white, be rotated slowly on a color wheel under bright illumination, a flickering play of colors appears on the surface. The proportions of black and white and the speed of rotation necessary to give the best results depend upon conditions, but a speed of two to five rotations per second is usually satisfactory.

This phenomenon is described by Charles S. Myers in his "Text-book of Experimental Psychology," part I, page 81.

Vernon W. Lemmon

Washington University,
St. Louis

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[5] E. Dingemanse, S. E. deJongh, S. Kober and E. Laqueur, *Deutsch. med. Woch.*, 56, 301, 1930.

[6] A. Butenandt, *Zeit. f. physiol. Chem.*, 188, 1, 1930.

[7] A. Butenandt, Abhandlungen d. Gesellschaft d. Wissenschaften z. Göttingen. III Folge, Heft 2, 1931.

[8] E. Allen and E. A. Doisy, *J. Am. Med. Assn.*, 81, 819, 1923.

SCIENTIFIC BOOKS

Die Forstinsekten Mitteleuropas. Ein Lehr- und Handbuch, by K. ESCHERICH, Vol. III. pp. xi + 725; figs. 608; 13 colored plates. Paul Parey, Berlin, 1931.

WHEN I first met Dr. Escherich (it was in 1906 in the big Forest School at Tharandt, Saxony) he told me that he was working on a revision of the fine work on the forest insects of middle Europe by Judeich and Nitsche. But Dr. Escherich was a very busy man, and, in 1911, spent several months in the United States traveling all over the country with me. On his return to Germany he wrote an admirable book on "Applied Entomology in the United States" and founded the German Society for Applied Entomology. It was not until 1913 that the first volume of this broadly planned work appeared. It was a well-illustrated volume of 432 pages and included a general consideration of insects, their morphology, anatomy and physiology, their development, their place in nature, their enemies and diseases, their outbreaks in disastrous numbers, the cultural means of avoiding damage and other general matters.

Then came the war, and Escherich was drawn into the military service of his country as a surgeon, and it was not until 1923 that the second volume was finished. I believe that I reviewed it in the columns of SCIENCE. It is a larger and very well-illustrated volume of 665 pages, and is devoted almost entirely to the Coleoptera, although there is a consideration of the less specialized orders. Naturally, the bark beetles are treated in much detail.

And now comes this magnificent third volume, which is devoted, as would be quite expected, almost wholly to the Lepidoptera—an order containing very many of the most destructive enemies of forest trees. And yet it is far from being simply a running account of or a detailed consideration of the species that thrive in Central Europe. It is the broadest kind of treatment. It goes into questions of morphology and anatomy, considers the damage done in general by this group, treats of them from the epidemiological point of view, and gives some space to the diseases of lepidopterous larvae. Since he has long studied the diseases of insects, he naturally gives some consideration to the different forms of these diseases, both those caused by bacteria and by microsporidia, and also naturally treats of the curious polyhedral diseases.

He displays rather fully the different systems of classification of this group, taking up consecutively the schemes of Boerner, Handlirsch, Hering, Heymons, Imms and Wolff and Krouwse. It is very interesting to see all these systems displayed by comparison, and it is also interesting to note that he gives Boerner's system precedence. The present writer is greatly pleased to note the prominence given in most of these systems to the ideas of our own J. H. Comstock and to his classification based largely on wing venation; in fact there are many illustrations of the wing venations of many families in general.

In his introduction Escherich speaks of the rapidly broadening work carried on in this field since the publication (in 1923) of his second volume. This is especially marked in the taking up of Ecology as applied to general forest conditions, as well as to all the inhabitants. Not only during that period, but for a number of years before that time, the forest has been becoming more and more thought of as a whole, and this of course is the broadly scientific way to do it. Escherich has been a leader in this line of thought.

The writer then introduces a synoptic arrangement of insect damage by Lepidoptera, and then goes on to treat the larger groups and the species under them in a consecutive manner. The illustrations are very numerous and many of them are original. The 13 colored plates are of course all new and are very well done.

The first volume of this very great work was naturally dedicated to Heinrich Nitsche, and there is an excellent portrait of him as a frontispiece. The second volume is dedicated to J. T. C. Ratzeburg, who is referred to "des Altmeisters und Begründers der angewandten Entomologie." Escherich is quite right in referring to Ratzeburg as practically the founder of applied entomology in Germany so far as forest insects are concerned, but I think that future history will show or should show that Escherich himself is very largely, if not wholly, responsible for the great revival and broadening of the whole field in his country. Of course others took a part, notably Ludzig Reh, but since Escherich returned to Europe in the autumn of 1911 and published his book on "Applied Entomology in the United States" his appeal to the entomologists of Germany to found a society dealing with the practical aspects of the science met with an immediate response, and since then big things have been done over there. Some of the soundest and most usable papers are now coming from that country.

Since the present writer is not a forest entomologist and since his knowledge of the German language has failed him of later years, he realizes that this review is not a competent one and that his warm friend Escherich will be disappointed. Nevertheless, it is plain that "The Forest Insects of Middle Europe" is a great work, and that it has been done by a master.

L. O. HOWARD

PARIS,
NOVEMBER 13, 1931

SPECIAL CORRESPONDENCE

BRITISH COMMITTEE ON PETROGRAPHIC CLASSIFICATION

At the Centenary Meeting of the British Association for the Advancement of Science a committee was appointed to examine and report upon petrographic classification and nomenclature. Many outside the few appointed are interested in the problems that will be discussed, and the committee therefore invites readers of Science to forward their views to the secretary.

In the first place the committee is attempting to evaluate the data available for establishing a sound classification of igneous rocks, and invites replies to the following questionnaire:

(1) Do you agree that classification should be based upon ascertainable facts (*i.e.*, composition, both mineral and chemical, texture and geological occurrence, as distinct from hypotheses—of origin, etc.)?

(2) To what extent should the classification be based upon chemical composition as expressed in percentages of specific oxides?

(3) How *far* should the classification be based upon facts of geographical distribution, *i.e.*, upon the recognition of petrographical provinces?

(4) *Are you in favor of the separation of igneous* rocks into *three* divisions: plutonic, hypabyssal (dyke rocks) and extrusive (lavas), following Rosenbusch and others; or into two divisions only, following Zirkel, Iddings and others?

(5) If in favor of three divisions, would you base the separation of the second from the third upon (a) texture or (b) actual geological occurrence?

(6) Should the naming of a rock be determined by the nature of the eruptive rocks with which it is associated? For example, trachybasalts (trachydolerites, *Rosenbusch*) are *only distinguished from normal basalts* by their occurrence with other alkali-rocks.

(7) In aiming at a complete classification for general acceptance by petrographers, are you in favor of retaining time-honored rock names, with meanings differing in many cases from those originally given to the names, or of introducing a new nomenclature?

(8) Do you think that the requirements of field geologists should be allowed to influence the classification and nomenclature of rocks, or should there be a simple classification with field-names for general use, and a more *complete classification* with *more exact names for* use in accurate petrography.

W. Campbell Smith,
Chairman.
A. K. Wells,
Secretary.

University of London

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE DEVICE FOR ADDING LOAD AT A STEADY RATE

The firmness or resistance to crushing of apples, pears and other fruits has been found to be a useful index of their maturity and suitability for harvest. To obtain this firmness in the form of a number mechanical devices are used. The time of harvest of green peas for canning is an extremely critical factor in the quality of the canned product and therefore an effort has been made at this station to devise a similar test for peas.[1] The spring balance used did not give the degree of precision desired, and the reading was visible for such a short time that it was likely to be misread.

In this work and in a similar test to determine the toughness of peas after canning[2] it has been thought to be necessary to add the load at a constant rate until the peas collapsed. To serve this purpose a dispensing burette of glass filled with mercury has been recommended.[2] Obviously mercury is open to objections on account of its cost and toxicity, to which must be added the fact that it is a liquid and therefore will flow more rapidly at a given position of the glass stopcock when the burette is nearly full than when it is nearly empty.

The device illustrated has certain advantages for this test and any similar test where the application of a load at a constant and reproducible rate up to fifty pounds (25 kilos) is desired. It is not essentially new, since it resembles a common device for determining the tensile strength of Portland cement. It uses alternatively lead shot or any other round pellets, and depends upon the fact that the flow of these through an opening under their own weight is easily stopped.

As a reservoir for the shot a cylindrical container is provided with a bottom in the shape of a cone of preferably less than 60°. The tip of the cone is cut off by successive trials until the opening left is just

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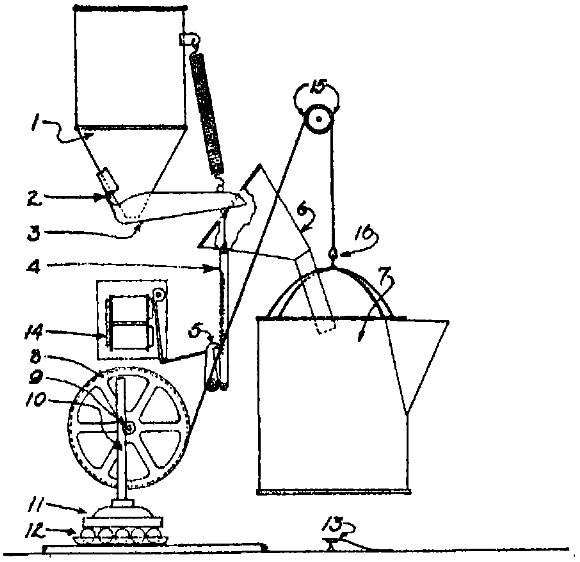
[1] N. Y. Agr. Exp. Sta. (Geneva) Tech. Bull., 176, 1931.

[2] U. S. Department of Agriculture Circular No. 164, 1931.



1, Reservoir for lead shot; 2, hinge; 3, movable pouring spout; 4, ratchet for holding spout at a given angle; 5, pawl to engage with ratchet bar 4; 6, guide funnel to direct shot into bucket 7; 7, detachable shot bucket; 8, grooved pulley; 9, pinion coaxial with pulley 7; 10, rack bar driven by pinion 9; 11, platen of glass which crushes peas; 12, receptacle for peas; 13, electrical contact for stopping shot at a predetermined position of the bucket; 14, electro-magnet which lifts pawl 5; 15, braided steel wire passing over pulley; 16, wire loop and hook for detaching bucket for weighing. It should be mentioned that parts 8, 9, 10, 11 and 12 are the essential parts of the device for determining the crushing value of peas described in N. Y. Agr. Exp. Sta. Tech. Bulletin 176, (Geneva) p. 12.

too large to be stopped up by the wedging of the shot or "bridging over." There is some latitude in its size, but it should be neither too large nor too small. One that has been found satisfactory for air rifle shot is 18 mm in diameter and will pass a dime but will retain a nickel.

Below the funnel a pouring spout is fastened by a hinge, so that shot passing through the funnel opening forms a pile upon its floor. This pile of shot grows until it surrounds the opening, whereupon the flow of shot from the reservoir is checked. If the inclination of the spout does not allow the shot to run out, the movement of shot from the reservoir stops instantly and completely. If the spout is tilted so that shot roll out the size of the pile is maintained from the reservoir, and a remarkably regular flow is kept up from the tip of the spout as long as there is any shot in the reservoir. A wide range of choice of rates of flow was found to be possible. The notches on the bar shown in the figure for holding the spout in any given position are 5 mm apart.

For an automatic cut-off the spout may be pulled back to the "off" position by the release of a spring. To prevent the violence of this motion from spilling some of the shot in the spout this is covered almost to the tip, and a suitably designed guide funnel is provided to direct all the shot that leaves the spout into the weighing bucket.

The drawing illustrates a device of this sort that was used with a previously described crushing tester for peas throughout an active season without requiring attention from the operator. The load reading is taken by detaching the bucket at leisure and weighing it upon a platform balance. It is emptied into the reservoir before attaching again and a pour-out is provided to make this more expeditious. It is not necessary to touch the shot with the hands.

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VOLTAGE-FREQUENCY RELATIONSHIPS IN ACTION CURRENTS

The common method for studying action currents has been to record photographically their frequencies, amplitudes and phase angles. It has yielded noteworthy results. However, certain questions have arisen not only in regard to the interpretation but also in connection with the reading of such recordings. The most of us have read the time interval between successive peaks in the wave train in order to obtain the frequency. This method is both inaccurate and inadequate. Granted that pictorially all the fundamental frequencies and their harmonic contents are present there is no known method for reading a non-repeating electrical wave such as we have represented in the action currents of nerve and muscle. In the vast majority of our action current records we could not fit even approximately a Fourier Series which proceeds by sines or cosines or multiples of a variable.

There is a method which overcomes, partially at least, the difficulties confronting us in a wave analysis of action currents. It amounts to determining what proportion of the total voltage generated lies within a certain frequency band. The frequency-intensity-phase angle relationships are thus resolved into a common denominator, voltage which for practical purposes may be thought of as power. Power equals the voltage squared divided by resistance and as we may hold the latter constant the voltage may be read as a direct expression of power. This unit of analysis is not only accurate but practical.

We have used two three-stage amplifiers, one of the resistance and the other of the impedance coupled type, a filter circuit and an alternating current voltmeter to study voltage-frequency relationships in action currents (Fig. 1). The overall frequency deflection characteristic of the two amplifiers was linear between 100 and 6,000 cycles per second. The voltmeter had no frequency discrimination between 80 and 5,000 cycles per second. All the commonly studied muscles of the human body have been scouted in this preliminary report. The subject was asked to tense the muscles from which action currents were being led off until a full-scale deflection of 9 volts was obtained on the voltmeter. Then as each filter circuit was introduced the new reduced voltmeter deflection was noted. Thus it was possible to determine what proportion of the voltage generated by the contracting muscles was within the frequency range being passed by the filter circuit.

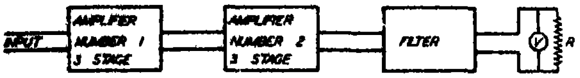

FIG. 1. A diagrammatic sketch of the voltage-frequency measuring unit.

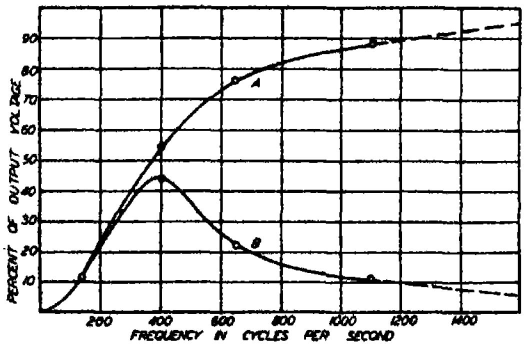

FIG. 2. Voltage-frequency curves for action currents from the tongue.

Curve B of Fig 2 shows the proportion of the total action current voltage in a given action current frequency band.[1] Several features of this curve strike our attention. Its general shape resembles that of a probability curve. The largest percentage of the voltage (44 per cent.) is expressed at 400 cycles per second and half of the total voltage generated falls between 130 and 450 cycles per second. This may be taken to mean that a large portion of the fundamental frequency is in the neighborhood of 400 cycles and that the second harmonic is an appreciable portion of the fundamental. Eleven per cent. of the voltage is above 1,100 cycles per second.

Curve A of Fig. 2 is an accumulative curve which shows what percentage of the total action current voltage may be expected to fall above or below a given action current frequency.

From these curves we may assume that the action current wave is a very complex one. It is indicative probably of direct, pulsating direct and alternating currents which may not have direct relationships with each other in respect to phase or time. The action current waves may not present harmonics. Rather they may be composed of fundamental, pure sine waves which are generated more or less crazily by the extremely complicated electrical generating network. If this is true then we should be able to isolate certain generating points by means of a system of filters having very narrow band widths.

It remains to test this method in a wide variety of problems in electrophysiology.

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SPECIAL ARTICLES

THE EFFECT OF CORTICO-ADRENAL EXTRACT ON ENERGY OUTPUT[1]

THE effect of extracts of the adrenal gland on the activity of muscle has been reported by many observers;[2] it is to be noted that attention has been directed primarily, however, to the action of epinephrine. More recently workers have reported on the effects produced by extracts of the adrenal cortex.[3] These investigations were in all cases carried out with nerve-muscle preparations. The intact, normal animal has not hitherto been used to demonstrate the effect of cortico-adrenal extract on the capacity to perform work. The substances used, furthermore, were of doubtful potency.

Dogs have been trained in this laboratory to run in a treadmill, and their total energy output in excess of basal metabolism has been determined in a series of experiments. The action of cortico-adrenal extract, prepared as previously described[4] according to the method of Swingle and Pfiffner,[5] and proved to be effective on adrenalectomized cats, was then tested. The material was injected intraperitoneally, and the subsequent effects on the ability to work were ascertained.

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[1] Reported in brief at the joint session of the Federation of American Societies for Experimental Biology, Montreal, Canada, April 11, 1931.

[2] M. Yoshimoto, *Quart. Jour. Exp. Physiol.*, 13: 5, 1922.

[3] A. Obré, *Compt. rend. soc. biol.*, 88: 585, 1923; J. Stefl, *ibid.*, 99: 985, 1928; F. de Mira and J. Fontes, *ibid.*, 98: 987, 1928; and 100: 602, 1929.

[1] Filter transmission characteristics were known and evaluated.

[4] S. W. Britton and H. Silvette, SCIENCE, 73: 322, March 20, 1931; *ibid.*, 373, April 3, 1931; *Amer. Jour. Physiol.*, 99: 15, 1931.

[5] W. W. Swingle and J. J. Pfiffner, *Amer. Jour. Physiol.*, 96: 153, 1931.

The working capacity of a normal (uninjected) dog is affected by training. It increases rapidly at first, but later it varies only slightly from the "standard output." Pulse rates increased from between 80 to 104 per minute during rest, to between 118 and 144 per minute at the end of a severe bout of exercise. The rates returned to normal within 20 to 40 minutes after the conclusion of an experiment. During the early stages of training the pulse rates were somewhat higher than those observed after a number of experiments had been carried out. The blood-sugar level in the normal dog showed a tendency to decrease during long-continued work, and to increase during the subsequent rest period. There was no close correlation between the glycemic level and the condition of the dog after exercise.

Injection of extract brought about a slight rise in the blood sugar of the resting, unexercised animal. The glycemic level was higher during experiments when the animal was under the influence of extract than when the effect of the extract was disappearing. Intraperitoneal injection of cortico-adrenal extract considerably increased the energy output. The extract was slowly acting in this respect, and exerted its maximum effect usually within 5 to 10 days. In one case, 20 cc of extract given intraperitoneally brought about a gradual increase in the total energy output in excess of basal metabolism. The increase reached a maximum of 115 per cent. in 10 days; thereafter a gradual decline in energy output was observed, and the previously established normal was eventually attained.

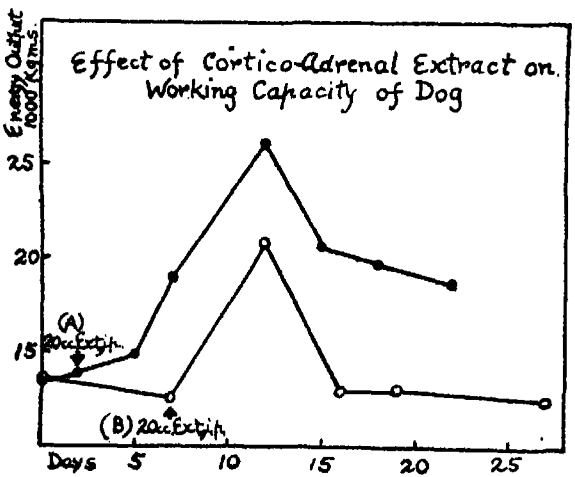

FIGURE 1

Fig. 1 shows graphically the effect of the extract on the energy output in excess of basal metabolism in two groups of experiments. Extracts of the adrenal cortex, of proven potency in overcoming adrenal insufficiency, are observed to augment markedly the capacity of the dog to perform work.

On man also cortico-adrenal extract has been found by ergographic record to increase notably the ability to carry out muscular exercise.

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VITAMIN G AND THE GROWTH FACTOR IN TOMATO JUICE

During the course of some vitamin assay determinations on canned tomato juice, we obtained evidence to show the lack of vitamin G (B_2) in either canned or fresh whole tomato juice. This is in disagreement with the findings of Goldberger and his associates[1, 2] and Hartley,[3] if we accept the statement that pellagra, black-tongue and dermatitis are all caused by the lack of vitamin G.

Evidence is also contained in table I for the differentiation of vitamin G and a purely growth-promoting factor. This distinction has previously been pointed out by Reader[4] and Williams and Waterman.[5]

The animals in the group reported here were young rats approximately four weeks old, weighing 30 to 40 grams each. They were placed in individual screen-bottomed cages and fed the following ration: Casein (acetic acid extracted) 18 per cent., cornstarch 66 per cent., Osborne and Mendel salt mixture 4 per cent., lard 10 per cent., and cod liver oil 2 drops per rat daily. After one week of depletion on the basal ration devoid of all factors of the B complex, constant weights were obtained. Graded doses of tomato juice, as indicated in the table, were then fed daily in separate cups for an eight weeks' period. Weights of the animals were recorded daily as well as symptoms of deficiency.

In the groups that lived long enough to develop a dermatitis, it always appeared in approximately 44 days, regardless of the amount of tomato juice fed. That the dermatitis shown by these rats was of nutritional origin, and not of epidemic nature, is indicated by the fact that they were kept on the same racks as some rats used in vitamin A assay experiments, and

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[6] P. F. duPont fellow in physiology.

[1] Goldberger, Wheeler, Lillie and Rogers, U. S. Public Health Reports, 42: 1299, 1927.

[2] Goldberger and Wheeler, U. S. Public Health Reports, 43: 1385, 1928.

[3] Hartley, 1930 (personal communication to Sherman and Smith), "The Vitamins," p. 139, 1931.

[4] Reader, *Biochem. J.*, 24: 1827, 1930.

[5] Williams and Waterman, *J. Biol. Chem.*, 78: 311, 1928.

TABLE I

Dose	No. rats in group	Days lived. Average	Polyneuritis[1] developed on day. Average	Dermatitis developed on day. Average	Average gain 8 weeks
					gms
Neg. controls	5	23	13.4	None	– 12.4
3 cc fresh juice ...	7	46	28.8	None	– 9.86
3 cc canned " [3] ..	7	45.8	27.1	None	– 11.0
4 cc fresh "	7	50.28	44.1	43.57	– 11.0
4 cc canned " ...	7	54.9	51.85	43.4	– 4.14
5 cc fresh " ...	7	56 +[2]	51.1	43.1	– 1.8
5 cc canned " ...	7	56 +	53.16	45.16	+ 12.7
6 cc fresh "	7	56 +	55.0	44.1	+ 1.3
6 cc canned " ...	7	56 +	56 +	44.7	+ 11.0
7 cc fresh "	7	56 +	56 +	43.5	+ 5.1
7 cc canned "	7	56 +	56 +	43.0	+ 10.3
			Average	43.8	

Autopsies in all cases confirmed the symptoms shown.

[1] Severe type.

[2] 56 + indicates animals still alive at termination of experiment.

[3] Beechnut Brand.

these rats showed no dermatitis. This shows the absence of vitamin G from the tomato juice.

On the smaller quantities of juice, the rats showed a loss of weight and on the larger doses a gain. It is shown that this gain can not be correlated with any presence of vitamin G and probably is not related to the presence of vitamin B (B_1) since Reader[4] and Williams and Lewis[6] have shown the absence of growth when rats were fed an abundance of this vitamin. This growth factor, therefore, probably is Reader's B_4 or the vitamin F, of which Sure, Smith and Kik[7] speak.

R. G. Daggs
A. G. Eaton

Department of Vital Economics,
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ARE LEAF LIPIDES RESPONSIVE TO SOLAR RADIATION?[1]

Experience reported elsewhere[2] led to the present inquiry. The earlier work had shown a consistent increase of lipide content in various plant species reared under Vita glass in comparison with common glass. Vita glass is one of the several products which transmits greater proportions of both ultra-violet and infra-red radiations than does common glass. Additional evidence of favorable rôles of this glass has been obtained which can not be presented in detail here. Livingston Globe tomato plants transplanted to the field from beneath Vita glass have yielded an earlier and larger crop than plants simultaneously transferred from common glass; and Early Fortune cucumber plants have developed more rapidly under Vita glass than under common glass in the early spring, ultimately producing larger fruits in the greenhouse. In these cases the air temperature was maintained essentially equal under the two forms of glass by use of a fan. Inasmuch as the tomato (*Lycopersicum esculentum*) had responded prominently in the manner indicated above, it was subjected to special examination of the lipide fraction.

A large quantity of leaf tissue was taken from potted plants of the Bonnie Best variety late in February. The height under common glass at this time was about 30 cm, while development had recently been noticeably more rapid under Vita glass.

Hot alcoholic extraction of 740 gm leaf tissue, as free from petioles as feasible, yielded about 12 gm of crude lipides. Determinations on separate samples of leaf blade tissue[3] indicated the presence of 1.76 per cent. chlorophylls (as potassium chlorophyllins) 0.007 per cent. carotin, and 0.053 per cent. xanthophylls in the dry tissue beneath common glass; with 1.50, 0.017 and 0.068 as the corresponding percentages under Vita glass. From the partially purified lipides precipitation of the sterols was effected as digitonides after saponification. In this form they amounted to 0.81 per cent. of the dry tissue under common glass and 0.87 under Vita glass. It is probable that alcohols of high molecular weight other than sterols and fatty acids associated with both in waxes were present, but these possibilities have not yet been investigated.

While the values here found for leaf pigments may be considered abnormal it must be recognized that the conditions of illumination, in relation to the requirements of this species, were also abnormal at the date of sampling, and had been more so during midwinter. It appears that the plane of carotinoids, and to a less extent that of sterols, has been favored by the increased radiation under Vita glass, with a corresponding decline in the content of chlorophylls. To be sure, the percentage fluctuations in lipide components here observed are of small magnitude. Their possible import would become more apparent were they converted to actual weights of constituents in equal numbers of plants under the two forms of glass. No record of plant yields were taken in this instance, but our earlier records, already mentioned, show marked increase in tissue production by the tomato under Vita glass. In view of the rôle of lipides, and particularly their fatty acid and sterol components, as carriers of energy, even small variations within this compositional fraction of plant tissue merit attention. Yet variation of its proportions in tissue might bear little relation to the potency of a growth promoting factor. One must admit that such a factor might either induce a growth rate parallel to its own accumulation or become activated to a special function without increase in amount. In the former case there would be no difference in percentage of the compound concerned as radiation treatment varied, while in the latter case it would decline in proportion as the tissue developed. In the present instance the increased content of carotinoids and sterols is merely suggestive of a causal relation of these lipides to increased vegetative development.

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[6] Williams and Lewis, *J. Biol. Chem.*, 89: 275, 1930.

[7] Sure, Smith and Kik, Science, 73: 242, 1931.

[1] Published with the approval of the director of the Wisconsin Agricultural Experiment Station.

[2] W. E. Tottingham and J. G. Moore, "Some Phases of Plant Development under Vita Glass," *Jour. Agric. Research*, 43: 133–163, 1931.

[3] With the aid of E. R. Tobey, graduate student.

The observations here briefly presented increase the desirability of further investigation of the influences of solar radiation in plant growth. As suggested in our earlier paper, it will be desirable to isolate the effects of ultra-violet from those of infra-red radiations, as may be accomplished by the use of a water cell to absorb the latter spectral region.

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EFFECT OF DISSOLVED CO_2 ON THE pH OF WATER

THE recent letter in SCIENCE by Mr. Emil Truog concerning the hydrogen-ion concentration of water in which carbon dioxide is dissolved, prompts me to present the following calculations which were made several years ago in connection with some calculations on the lead carbonate equilibrium, and which, I think, have not appeared elsewhere.

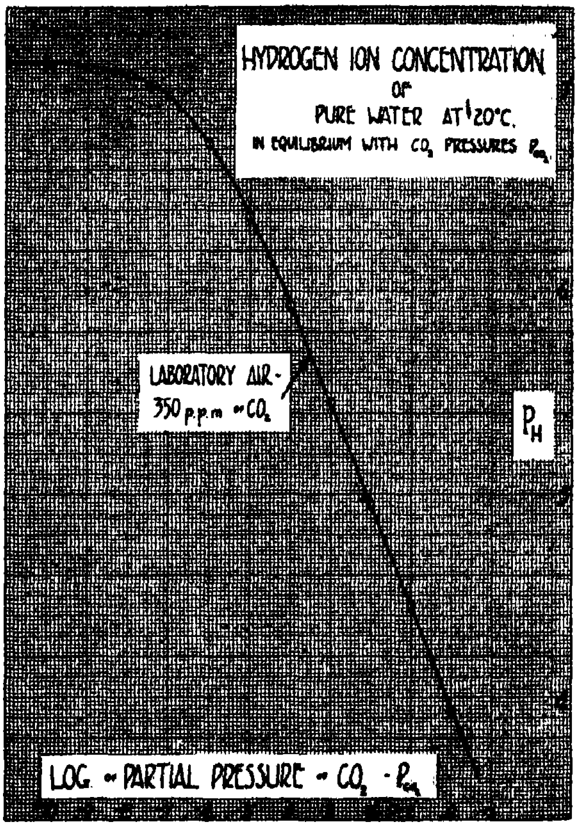
Setting up the familiar equations of carbonate equilibria with values of the constants indicated,

$$(1)\quad [H^+]\ [OH'] = K_w = 0.54 \times 10^{-14}\ (20°\text{ C.})$$
$$(2)\quad [H^+]\ [HCO_3']/[H_2CO_3] = k_1 = 3.18 \times 10^{-7}\ (20°)$$
$$(3)\quad [H^+]\ [CO_3'']/[HCO_3'] = k_2 = 3.54 \times 10^{-11}\ (20°)$$
$$(4)\quad [H_2CO_3] = ncP\quad nc = .0393\ (20°)$$
$$(4)\quad [H_2CO_3] = ncP\qquad nc = .0393\ (20°)$$
$$(5)\quad [H^+] = 2\,[CO_3''] + [HCO_3'] + [OH']$$

we arrive at the following equation containing only constants and the two unknowns, $[H^+]$ and P

$$(6)\quad [H^+] = \frac{2k_1 k_2 ncP}{[H^+]^2} + \frac{k_1 ncP}{[H^+]} + \frac{K_w}{[H^+]}$$

This equation (6) is solved for $[H^+]$ by substituting values of P, the partial pressure of CO_2 with which the pure water is in equilibrium.



The curve of pH plotted against log of the partial pressure of CO_2 is practically linear from one atmosphere of CO_2 to about 10^{-6} atmospheres (which includes the range usually encountered) and for a pressure of CO_2, corresponding to 350 parts per million in air—an average value—gives a calculated pH of 5.68 which agrees well with the value given by Truog. From 10^{-6} of an atmosphere of CO_2 to zero pressure of CO_2, the curve rapidly approaches the dissociation constant of pure water as asymptote. The curve shows these results graphically.

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SCIENCE

Vol. 75 Friday, February 26, 1932 No. 1939

How the Other Half Live: Professor Robert Hegner 225

Our Debt to Faraday's Epoch: Professor Dugald C. Jackson 230

Obituary:
In Commemoration of Stephen Tyng Mather; Memorial to Thomas Alva Edison; Memorials; Recent Deaths 232

Scientific Events:
The American Chemical Society; National Research Fellowships in the Biological Sciences; Honorary Degrees Conferred at the Bicentennial of the George Washington University; Awards of the American Institute of Mining and Metallurgical Engineers; The Hayden Memorial Geological Award for 1932 234

Scientific Notes and News 237

Discussion:
The Process of Giordano Bruno: Professor K. F. Herzfeld. *A Small Insect which Stings Severely:* Professor E. O. Essig. *Hamivorous Fish:* Professor W. A. Hamor. *Relations between Fundamental Physical Constants:* Dr. J. E. Mills 241

Societies and Academies:
The Northwest Scientific Association: J. W. Hungate. *Fourth Round Table of Catholic Scientists held in New Orleans:* Dr. A. M. Keefe 244

Scientific Apparatus and Laboratory Methods:
A Rotary Myograph: Dr. Seward E. Owen. *Multiple Laboratory Incubator for the Biological Study of Chick Embryo:* Dr. Alexis L. Romanoff 245

Special Articles:
On the Laws of Kinetic Systems: Dr. W. H. Longley. *Rate of Sea Cliff Recession on the Property of the Scripps Institution of Oceanography at La Jolla, California:* Dr. T. Wayland Vaughan 248

Science News 8

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HOW THE OTHER HALF LIVE[1]

By Professor ROBERT HEGNER

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The title of my address this evening was called for by our secretary eight months ago; this made it necessary for me to select a title broad enough to cover anything I might wish to say. I was quite certain at the time that I would talk about parasites. I might equally well have chosen the title "How the Neglected Half Live" instead of "How the Other Half Live," since very few zoologists seem to realize what a large part of the animal kingdom consists of parasites. Those of us who have selected parasitology as a field of research know that every species of animal that has been studied carefully harbors within it one or more species of parasites. Man, for example, is known to be parasitized by about 25 different species of protozoa, 85 different species of worms and an uncertain number of different species of arthropods, the exact number depending on one's definition of a parasite. Many of these parasites appear to exist only in man. A similar condition prevails among domesticated animals and common wild animals and probably is universal. Hence it would appear that there are at least as many species of animal parasites as there are species of animal hosts for them to live in.

The number of individuals belonging to various species of parasites is astounding. The number of ciliates in the stomach of a cow, or cecum of a horse, the number of flagellates in the cecum of a guinea-pig, the number of malaria parasites in the blood of a human being suffering from malaria, and the number of amoebae in a dysenteric patient mounts into the billions.

Parasites have attracted more attention in recent years than formerly, but I believe zoologists in general still feel that there is some fundamental difference between free-living and parasitic animals and that the latter are of no particular importance as material for teaching purposes and research. This seems clear from the relatively small amount of space devoted to parasitology by teachers of zoology who have recently published text-books to fit their courses. For example, the "Invertebrate Zoology" used in the course at Woods Hole includes outlines for the study of 97 species of animals, only 5 of which are parasites. A text-book designed for courses in college zoology and written by well-known zoologists at the University of Missouri contains accounts of only three parasites and devotes eleven of a total of 585 pages to parasites and parasitism. A biology prepared for college students by a professor at Yale University contains 501 pages; two sections of this book comprising 22 pages are devoted to parasites. In a book on ecology written by a professor of zoology at Duke University, the subject of parasitism is relegated to the next to the last chapter and occupies 21 of a total of 417 pages. I feel free to criticize others for neglecting parasites in their text-books, since I have been guilty of the same offense.

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[1] Address of the vice president and chairman of Section F, American Association for the Advancement of Science, presented at the Zoologists' dinner in New Orleans on December 30, 1931.

Every one, I think, will agree with me that such a vast assemblage of animals deserves to be treated more fully than these statistics indicate is now being done. I should like to detail to you at some length the many advantages parasites present for biological study; how easily they may be obtained in large numbers; how interesting are their relations to their environment; how numerous are the problems of fundamental biological significance offered by them; and what great opportunities they give us, especially for the study of experimental evolution. However, because of lack of time, I will limit myself to a discussion of one group of parasites in a single host, namely, the protozoa of man.

For hundreds of years investigators have been studying the structure and physiology of the human body, and no other animal has ever been subjected to such careful and exhaustive examination. However, when all this knowledge has been assembled, it represents only half of the story. What is lacking is a knowledge of the fauna that use the human body as a residence, a food supply and a common carrier.

When one observes a relative or a colleague he may think he is seeing an individual, whereas, as a matter of fact, he is really looking at a menagerie. The human body may appropriately be compared to a zoological garden closed for the winter. The animals are there but one can't see them because they are kept concealed behind closed doors. Similarly the protozoan parasites of man are concealed from view because they all live inside of the body. But a proper examination will reveal them and I propose this evening that we take a peep through the keyhole into this marvelous assemblage of animal life.

The protozoan parasites of man may conveniently be divided into two groups on the basis of habitat. One group live in the digestive tract and are commonly known as intestinal protozoa. The other group live in the blood stream and are known as blood-inhabiting protozoa. These protozoa do not wander all over the body at will, but each of the 25 species that occur in man is definitely localized in some particular region of the body, just as free-living animals occupy definite habitats on the surface of the earth.

It is surprising to most people to learn that about one half of the general population are infected with a mouth-inhabiting amoeba. This organism lives in the tartar around the base of the teeth. It has been accused of being the causative organism of pyorrhea but has not been definitely incriminated. Transmission from one person to another no doubt takes place by contact. The logical conclusion is that those who are not infected have never been kissed. Human nature being what it is, there is no known method of preventing the spread of this amoeba. The other protozoon that lives in the mouth is a flagellate that is also probably non-pathogenic, although it occurs more frequently in diseased than in healthy mouths.

The two species of protozoa that live in the small intestine must be able to maintain themselves there against the rapid movement of food from the stomach to the large intestine. One type is a flagellate which possesses a sucking disc, by means of which it attaches itself to the intestinal wall to prevent being swept away. The other type is a coccidium which maintains itself by penetrating the cells of the intestinal wall. Coccidia are all pathogenic but are very rare in man.

The ten different species of protozoa that live in the large intestine are all more or less similar as regards their life histories. Most of them live in the lumen of the intestine and are harmless; but two of them, an amoeba and a ciliate, are responsible for the production of dysentery and are often lethal. Although 10 per cent. of the general population is infected with the dysentery amoeba, most of those infected are in the carrier condition, that is, although the organism is present, the human body is able to repair the damage caused by it so rapidly that no symptoms appear. This pathogenic amoeba is particularly prevalent in tropical countries and is responsible for thousands of deaths every year. Fortunately, several drugs specific for this organism have been discovered, and whereas formerly patients were almost certain to die in agony, now proper treatment just as certainly restores the patient to health.

The ciliate that causes dysentery in man is of considerable interest because we share it with monkeys and pigs; probably 80 per cent. of the pigs in this country have intestines swarming with this ciliate. Apparently they do not injure the pigs in any way, but the cysts that they produce are sometimes swallowed by susceptible human beings in whom they bring about dysenteric conditions. Most people are evidently not susceptible to this ciliate, since our food and drink must frequently be contaminated. A study of the cases that do occur reveals the fact that the patients had been associated in some way with pigs or had eaten insufficiently cooked pork products.

The other protozoan inhabitants of the large intestine of man are all supposed to be non-pathogenic, although certain protozoologists claim that several species of flagellates bring about intestinal disturbances. From about 5 to 50 per cent. of the general population may be infected with these intestinal protozoa. Inasmuch as no antagonism exists among these organisms and one person may be infected with the entire job lot assortment, it is probable that all but a very few of us have been unconsciously furnishing a residence and a food supply for several of these parasites and were totally ignorant of it. As a matter of fact, the material used in my laboratory at the Johns Hopkins University for the study of these protozoa is almost all furnished by the laboratory staff.

There is an interesting relation between these intestinal protozoa and the character of our diet. Meat-eating animals are not ordinarily infected with them, but vegetarians are very highly parasitized. This situation led to some experimental work which has demonstrated the effectiveness of animal proteins in preventing infection and of carbohydrates in intensifying infections. Casein seems to be the best of the proteins. A diet consisting largely of casein soon brings about a decrease in the number of certain organisms and often leads to their total elimination. Starch, on the other hand, provides a favorite article of food and results in an enormous increase of certain of these protozoa. The fact that rats fed on a high protein diet lost their intestinal protozoa suggested at once the treatment of human infections by modifying the diet. A series of menus were prepared in which animal proteins predominated, but which included such items as pickles and strawberries to make the food more palatable. The results when applied to human patients suffering from digestive disturbances due to certain protozoa were very striking; in many cases the protozoa disappeared along with the symptoms within a week. Two objections to this treatment have been reported; one patient was unable to get strawberries and another patient just couldn't eat pickles.

The blood-inhabiting protozoa of man are local in their distribution. The leishmanias, which cause kala-azar and oriental sore in the Far and Near East, and cutaneous ulcer in South America, are flagellate protozoa, all pathogenic and some of them very dangerous. The organism of kala-azar destroys thousands of human lives every year in Asia. Oriental sore is a disease that is called Delhi boil by the inhabitants of Bagdad, and Bagdad sore by the natives of Delhi. It is not a fatal disease, but leaves permanent scars in its wake. It is apt to occur on the face, being transmitted by a biting sand-fly. One attack gives immunity, hence it is the custom in certain eastern regions to inoculate children on some part of the body other than the face much as we vaccinate against smallpox. The resulting infection is mild, gives immunity and hence insures against facial disfigurement. It is becoming increasingly more difficult, however, because of modern styles of dress, to find a part of the body for vaccination that is not exposed.

Trypanosomes that are responsible for African sleeping sickness are also flagellates. They live in the blood stream and are transmitted from one host to another by tsetse flies. They are able to live not only in human beings but also in game animals, especially antelope; hence the flies have a constant reservoir from which they may become infected. Large sections of Africa are uninhabitable because of the presence of these protozoan organisms. Drugs have been developed in Germany, France and the United States that are effective against sleeping sickness if administered in the early stages of the disease. African sleeping sickness should be distinguished from Encephalitis lethargica, a type of sleeping sickness that occurs in this country and is an entirely different disease, the causative organism of which is still unknown.

Perhaps the most interesting of all the protozoa that live in man is the malaria organism. Malaria is undoubtedly the most important disease in tropical and subtropical regions and in some respects is the most important of all human diseases, since it is responsible for preventing the colonization of vast areas in the most fertile regions of the earth. As you all know, only female mosquitoes are able to transmit the disease, and even the female is quite innocent of any harmful intention, since she doesn't know the blood she sucks into her stomach is loaded. When she bites she regurgitates juices from her salivary glands into the blood stream of her victim, and in this salivary secretion are suspended the infective stages of the malaria organism. Malaria could easily be eradicated therefore, if we could teach mosquitoes not to spit. Malarial organisms occur in birds, monkeys and other animals as well as in man, but the bird malaria parasites are unable to set up infections in human beings. We are not yet certain whether the parasites of man and monkeys are capable of setting up cross infections.

Much can be done to control malaria by killing mosquitoes, but there are still many problems unsolved. One of the most important of these is the problem of relapse. Quinine and the new drug plasmochin destroy most of the parasites in a patient and give relief from symptoms, but they do not ordinarily eliminate all the parasites and the host is thus in the carrier condition and liable to suffer a relapse at any time. What we need more than anything else to aid us in eradicating malaria is a drug that will destroy all the parasites in an infected person and thus prevent relapses. Many chemists and zoologists are now engaged in studies directed toward the discovery of such a drug.

Even if all the parasites are destroyed, we are in constant danger of reinfection. You probably all know about the student who was once asked to name a famous parasitologist of the past. "Milton," he replied, "because Milton wrote 'Parasites Lost' and 'Parasites Regained.'" The problem of reinfection must be solved by those who are in charge of our public health activities. As every one knows, the most conspicuous successes in the field of public health have been the campaigns for the eradication of such diseases as malaria and yellow fever. In fact, the residents of the Panama Canal Zone call a policeman if they are attacked by a mosquito.

Sometimes one type of parasite preys upon another type of parasite. An interesting and important case of this so-called hyperparasitism that has attracted wide-spread attention during the past decade is that of the effects of malaria on general paralysis or paresis. Malarial organisms, when inoculated into patients suffering from general paralysis, bring about a distinct improvement in the course of the disease. Patients are allowed to go through eight or nine malarial chills and fever and are then treated with quinine to check the malaria. The results of investigations of this type carried on in various parts of the world have almost all been favorable.

This review of the protozoan parasites that live in man may serve to refresh your memory regarding these interesting animals, but to determine satisfactorily how the other half live it is necessary to follow their entire life cycle from the invasion of a host to the escape of the offspring from that host. Much research is necessary to work out life cycles and the view-points of investigators working in several different fields must be combined before a satisfactory ensemble is attained. Zoologists are primarily interested in the taxonomy, morphology, physiology and development of the parasite; medical men are more interested in the reactions of the host than they are in the parasitic organisms that cause the diseases; and students of hygiene and public health emphasize those phases in the life cycle that have a bearing on the transmission of the parasite from one host to another.

I have attempted to combine the view-points represented by these three types of investigators into one program which I call "Host-Parasite Relations." In this program the events in the life cycle of the parasite, the reactions of the host to the invasion of the parasite, and the transmission of the parasite from one host to another are arranged in logical order beginning with the exogenous existence of the organism. Such a program may be compared with the study of a free-living protozoon involving the investigation of its life cycle, the interactions between it and the environment and its geographical distribution. There is no real difference between free-living and parasitic protozoa except that of environment, and the environment of parasites appears to be remarkably similar to that of free-living animals when the two are analyzed carefully.

Perhaps the best stage with which to begin a study of host-parasite relations is that during which the organism is transmitted from one host to another. Among human protozoa this is accomplished either by an intermediate host, for example by mosquitoes in malaria or tsetse flies in sleeping sickness, or by cysts that are swallowed in contaminated food or drink as in amoebic dysentery. It can not be too strongly emphasized that the parasite is passive and the host active during transmission and that consequently we are responsible for our own infections, either because we fail to prevent mosquitoes or other blood-sucking insects from biting us or because we allow our food and drink to become contaminated with fecal material containing protozoan cysts.

After gaining entrance to the body the protozoa are distributed to the primary sites of infection either in the blood stream or by the movements of the alimentary canal. This distribution is brought about almost entirely by the physiological activities of the host, the parasite remaining passive. The site of infection, whether the red blood cells, blood plasma, endothelial cells, muscle cells, mouth, duodenum or colon, is no doubt largely determined by the reactions of the different parasites to various stimuli; just as free-living protozoa become localized in particular types of habitats in a pond or in the ocean.

During the period when a protozoan parasite is becoming established in the human body there is a struggle going on between host and parasite. The host exhibits a natural resistance to infection which the parasite must overcome. For example, the acid condition of the stomach contents is detrimental to active protozoa; this obstacle is overcome by intetinal protozoa by the production of cysts whose walls resist the action of the digestive juices and enable the organism to pass through the stomach unharmed. To a zoologist who has attempted to rear pure lines of free-living protozoa, one of the most remarkable features involved in the life cycles of parasitic protozoa is their ability to remain vigorous for an indefinite number of generations in a medium that is practically constant in temperature, density, chemical composition and food content. For example, the parasite of bird malaria with which we have worked in my laboratory for the past twelve years was obtained by Dr. Eugene Whitmore from an English sparrow in Brooklyn, N. Y., in 1913 and has lived in canaries ever since, multiplying once per day by asexual reproduction without the intervention of sexual reproduction or endomixis and without any perceptible loss of vigor. During this period these parasites have passed through over 6,600 asexual generations.

The interactions of host and parasite result in various changes in both organisms. If the host does not successfully resist the parasite it suffers injury, as evidenced by the appearance of symptoms which may lead to death. Or the host may build up resistance against the parasite, thus becoming immune and recovering from the attack. Often an equilibrium is established between host and parasite, the injuries of the host being repaired as rapidly as inflicted; the host thus becomes what is known as a carrier. Any change in the host that lowers its resistance and any change in the parasite that increases its virulence upsets this equilibrium, and the attack of the parasite again brings about the appearance of symptoms.

One of the most interesting phases of our program is that of host-parasite specificity. In many cases a particular species of host is parasitized by species of protozoa that occur in no other species of animal. Thus the 25 species of protozoa known to live in the human body are rarely found in lower animals. The rat, for example, which is so closely associated with man and lives on a somewhat similar diet, is parasitized by at least seven species of protozoa that belong to seven genera represented among human protozoa; these seven species, however, are morphologically different and may easily be distinguished from species belonging to the same genera in man. This is not true when the protozoa of man and monkeys are compared. Of the 25 species that live in man, 20 indistinguishable from them have been reported from monkeys and only 3 species have been recorded from monkeys that are not known to live in man. The assumption is reasonable that animals whose parasites resemble each other closely are near of kin. If this is true, we may add the species identity of parasitic protozoa to the other types of evidence that lead us to believe in the close kinship between monkeys and man.

The protozoan parasites that I have described this evening are considered to be normal inhabitants of the human body, and all of us probably serve as hosts for one or more species. The expression "we all" often applied by Southerners to a single person appears, therefore, to be quite appropriate. In many regions, where such diseases as malaria occur, every human being is infected from soon after birth until death. Fortunately for us, most of our protozoan parasites are not destructive, and we carry them about with us unharmed. It isn't pleasant, however, to realize how many millions of creeping microbes use our bodies as a protozoan universe, and it is natural for us to want to do something about it. Much has been done and is being done. Malaria, amoebic dysentery, sleeping sickness and other protozoan diseases of man have lost much of their terrors because therapeutic agents and methods of control have been discovered and put into practice.

However, protozoology needs more publicity than it has at present; probably not one person in a carload even knows that such creatures as protozoa exist. Perhaps, in course of time, biologists may be able to defaunate the human body and thus initiate a race of supermen. Modern facilities for rapid transit are, however, making this continually more difficult. Disease-producing organisms may be transported from one locality to another and for long distances either by human carriers or by intermediate hosts. The intermediate hosts of protozoan parasites are usually flies and bloodsucking insects; these are frequently transported from one country to another. It is usually not necessary, however, to take drastic action for the purpose of preventing the importation of animal parasites into the United States because of their complicated life-histories. For example, trypanosome diseases can not be transmitted in a locality where certain species of tsetse flies are absent, even if animals with trypanosomes in their blood are present in large numbers.

One field in which the study of the protozoa of man has taken a leading rôle is that of rendering the tropics as habitable for man and his domesticated animals as are the temperate regions of the earth. Such conquests as that of malaria and yellow fever in Havana and the Panama Canal Zone have a distinct bearing upon one of the greatest problems before mankind at the present time—the problem of population. Statistics show that the world's population has increased about two and one half times during the past century. Many methods of preventing further increases in population have been suggested, but no one can predict what the future may have in store for us in this direction. We must, however, face the problem that confronts us to-day. In tropical countries large areas of land exist that are now sparsely inhabited and unproductive. That these tropical regions can be made healthful to men from the colder regions of the earth has been proved again and again by various nations that have founded colonies in the torrid zone. To do this it has only been necessay to control certain diseases, and these diseases have been for the most part due to animal parasites or their transmitting agents.

My remarks this evening may lead you to believe that we think we really know something about the protozoa of man. This, however, is far from the truth. One has only to look back to the situation that existed 30 years ago to realize our own position to-day. Zoologists in 1900 believed that they were living in an enlightened age, but now we know that they were densely ignorant. It seems probable that in 1960, 1931 will likewise be considered among the zoological dark ages. Hence, although we have made a good beginning in the study of parasitic protozoa we must continue our efforts until we are able to escape from the humiliating condition that exists at the present time and man ceases to be held in bondage by his invisible fauna.

OUR DEBT TO FARADAY'S EPOCH[1]

By Professor DUGALD C. JACKSON
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One hundred years ago the first third of the nineteenth century was drawing to a close, as now is the first third of the present century. You may reflect that the stated facts are obvious and that the whole statement is a platitude. I center your attention on them with the clearly defined purpose of emphasizing the debt which we, in this first third of the present century, owe to discoveries originating in that significant first third of the immediately past century.

Using that first third as a landmark: James Watt, the founder of mechanical engineering, had already proved the usefulness of his conception of the steam engine; Lavoisier, the father of modern chemical thought, had just been guillotined by the revolutionists in Paris. Science and engineering had taken on new aspects, and the spirit of inquiry was abroad in a newly felt freedom.

Exclusive of those features of sentiment and religion, which must be dealt with independently because they are primarily of intellectual and spiritual moment, rather than pertaining to the physical conditions of health, comfort and convenience of the body, we are primarily dependent in our present-day living methods on a few great modern developments. Preventive medicine, sanitation, sound food preservation, transportation by water, rail and highway, electric quick communication, ready transmission of power, convenient artificial illumination, largely determine our relatively great assurance of health and comfort in life compared with the conditions of a couple of centuries ago.

I wonder whether any of you express to yourselves and associates doubts regarding the relative advantages in favor of our present status measured in health, comfort and opportunities for all men and women in the democratic countries, compared with the conditions of the common people of the great countries of a few generations ago. If you do, I assure you that it is because you have failed to study the effect of the changes of conditions; or, having studied them, you have failed to accurately interpret their meaning. When I speak thus in comparative favor of our own times I refer not only to average opportunities for health, comfort and happiness in life, but also to the conditions available particularly for those who are little favored with influence or money.

If you wish a bit of my meaning more fully illustrated, I invite you to drive through the Värmland and Dalecarlia provinces of Sweden, as my wife and I did last summer in a pigrimage to the birthplace, school place and tomb of John Ericsson. And then compare, feature by feature, the present comfortable, well-supplied life of the present dwellers, living secure in that community, with the sordid hardships of the life there several generations ago, which are identically described by Selma Lagerlöf in her distinguished saga of Gösta Berling. I am sure that the sordidness and hardships of the older life and the relatively healthful, comfortable and happy conditions of the present life in the area will impress you. The changes are revolutionary and heavily favorable to the present. Food is now certain for all. Children are born under sanitary conditions and with suitable medical aid. The sick are properly cared for. Products of the farms, forests and mines are of definite value. Reasonable periods of sleep and recreation are within command of all. Shelter and clothing are assured. This makes a deep-seated contrast with the conditions in the older period; and the healthier and happier hues are mostly associated with the later period.

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[1] Address delivered at the celebration of Faraday's life held in New York on November 18, 1932, by the New York Museum of Science and Industry.

We may reasonably ask how this difference has come to pass. The answer is in terms of enlarged science and broadened engineering; in rail transportation and steam navigation, automotive highways, quick electrical communication by telegraph and telephone, ready transmission of electric power generated from water-power, convenient sources of artificial illumination, preventive medicine and sanitation. One swallow does not make a summer nor one snowflake a winter, but the given example is indicative. A scientist is skeptical in drawing conclusions (and the competent engineer is a scientist), but he does not misconstrue facts and determined relationships. One of the hindrances which occur when one tries to secure a fair and accurate understanding, from such a comparison of the present with the past, lies in the difficulty of divesting a mind of present-day knowledge when considering the past, and thus the conditions of the past are given an interpretation which is unduly favorable because it is flavored by knowledge extracted from the present. Critics of our present-day social organization frequently fill with this error the comparisons which they make. Obviously there are faults in our present social organism. We all know that they are many and are sometimes grossly unfair as between men; but they are not so many or so unfair as in previous centuries. To prescribe a cure calls for keener relating together of facts than usually characterizes self-constituted social physicians.

But that first third of the nineteenth century—what of it and why our debt to it?

In the early part of that period, Fulton, the father of steam navigation, produced the first operating embodiments of the steamboat, the conception of which had come to him a few years earlier. George Stephenson, the father of railroad transportation, in this period wrought out in metal his conception of the iron horse as a device with smooth wheels running on smooth rails and yet capable of drawing after it great loads; and in 1829 he conclusively proved against all skeptical opinion that his device outclassed horses as a motive device. Morse had his great conception of the electric telegraph during the period, although it was some years later before he succeeded in embodying his conception in a successfully working telegraph structure, and it was some decades more before Bell produced the telephone. Faraday, the gifted experimenter in the fields of chemistry, metallurgy, electrochemistry, electricity and magnetism, in that period laid the foundation for all our electrical power and electrical illumination developments.

There, in that one third of a century, lie the roots of all our developments of steam navigation, rail transportation and electric communication which have made, for most of the world, one harvest; and in the end will apparently succeed in making it of one heart.

Our hearts are torn by pathetic accounts of drought and flood and succeeding famine in the central provinces of China. We, in this country, which is bound indissolubly together with bonds of quick communication and efficient transportation, find it difficult to believe that starvation following failure of crops in inland China is due mostly to ancient and rudimentary means of communication and transportation, and not to mismanagement. But such are the facts. A short century ago, starvation of populations by famine was of common-place occurrence after the failure of crops in almost any of the inland provinces of India, which country has a population measurably in keeping with that of China. Today the occurrence of famine in acute degree in India is beyond the margin of our thought. This change in India has been wrought mostly by the wonders of electric telegraphy and steam railroad transportation.

As recently as when I was a boy severe shortages of the potato crops in some districts of Ireland caused famine-starvation to a degree and with a frequency that led that island to be sympathetically referred to as the Stricken Isle. What of the present day in that isle? How many of you under forty have thought of ravages of famine decimating the Irish population? The differences distinguishing the present conditions and those of the not far distant famine days of Ireland include the influences of more scientific cultivation of crops, improved sanitation, and recently the convenient provision of electrically transmitted power; but the major changes have been in the wake of railroad transportation and electrical communication.

When the great people of China have knit their nation together with bonds of electric telegraphy and telephony, railroad transportation, automotive highways and convenient electric power lines, their inland provinces will no longer be periodically ravaged by famine and pestilence, as the facilities for transportation and communication will give means for forefending against those great disasters.

This is enough of the "particular instance" to emphasize the point, and perhaps as much as your interest will support. You will observe the ameliorating influence of rail transportation, electric communication and electric power on the conditions of life. This may seem purely materialistic to some; but that is a misinterpretation, since intellectual qualities grow greatest where material opportunities are favorable, even though such opportunities may be embraced in only a Bohemian or partial manner. Moreover, improved communication and transportation have strongly advanced the influence of the premier invention of printing on the culture and mutual sympathies of the world, and have largely expanded the radius of spiritual influences.

You will note also the insistence with which electric communication and electric power appear in the recital. These have their roots in the magnificent discoveries of Faraday, Joseph Henry and others in that third of a century which we have been considering. Their growth has been extended by the discoveries and inventions of many others working in distinguished ways from then until the present day.

Fundamental discoveries which bring such great results are the fruits of curiosity working under ideal conditions; that is, of the spirit of inquiry applied to the disclosure of new facts or inferred relations. With increasing rarity they are the result of one scientist's efforts, although that was a characteristic of Faraday's days. An entire laboratory group, perhaps working under some inspired leader, nowadays more often brings projects to successful conclusions. Utilizing both of these sources—individual genius and group cooperation—we have admirable centers in the university laboratories (including therewith laboratories of the engineering schools) to carry forward in paths corresponding to those that have led to such impressive improvements in the conditions of healthfulness, comfort and happiness of life for all individuals coming under their influence.

The extraordinary influence of the universities heretofore is worth briefly enumerating, but I have time to sketch the affair in one branch only, and I will choose electrical engineering, in regard to which I am best informed. Galvani, Volta, Oersted, Ampere, Ohm, Joseph Henry, Maxwell, Kelvin, Helmholtz, Hertz, Roentgen, Pupin and other discoverers of natural phenomena or expounders of relations upon which most of the structure of electrical engineering is founded, worked in university circles. Alexander Graham Bell was professionally a teacher, although his great invention of the telephone can not fairly be accredited to educational laboratories. Elihu Thomson was originally in the post of a teacher and many of his widely influential inventions arose from experimental investigations performed in those days. Faraday's location during his great discoveries in chemistry, electromagnetism and other branches of physics was in the Royal Institution, which was founded by Sir Joseph Banks, Count Rumford and others with objects which include "the facilitating of mechanical inventions, the promoting of their use, and the teaching of science and its applications by means of lectures and experiments."

The impulse of curiosity or spirit of inquiry, of which scientific investigation or research is the embodiment, is well nurtured in the university atmosphere, where the relations of science are brought to bear on enthusiastic young minds. It is an integral part of properly conceived engineering education, and is especially serviceable in those institutions where the students are encouraged to independent scientific investigation and thought. The result of newly vitalizing this view in engineering education is bringing good results where it is in effect. This experience gives assurance that we may rely on our present generation to work some of the faults out of our social organism and carry forward the improvement of modes of life by farther application of scientific discovery. One of the needs is to provide the better engineering schools with means to as closely associate their work with fundamental economics as they are now associating it with fundamental science.

We have now considered briefly some of the achievements which were made in the first third of the nineteenth century, that expired nearly one hundred years ago, and also the effects of those influences on our present-day life. Shining forth amongst it all is the glorious significance of Faraday's own work, which exemplifies

> . . . the vital words and deeds
> Of minds whom neither time nor change can tame.

OBITUARY

IN COMMEMORATION OF STEPHEN TYNG MATHER

In memory of Stephen Tyng Mather, founder and former director of the National Park Service, who died two years ago, the first of the bronze plaques designed by Mr. Bryant Baker, of New York, for The Stephen T. Mather Appreciation, of which Mr. John Hays Hammond is chairman, will be unveiled in Mount Rainier National Park on July 4, Mr. Mather's sixty-fifth birthday anniversary.

The plaque is oblong in shape, measuring 30 by 35 inches. The deep interest of Mr. Mather in outdoor life inspired the design, at the right of which, against a background of mountain ranges, is presented in *bas relief* his portrait looking toward a group of trees. Above the portrait is the legend:

Stephen Tyng Mather, July 4, 1867—January 22, 1930.

Below it, across the base of the plaque, is the following inscription:

He laid the foundation of the National Park Service, defining and establishing the policies under which its areas shall be developed and conserved unimpaired for future generations. There will never come an end to the good that he has done.

A plaque is being placed on the south rim, near Yavapai Point, of Grand Canyon National Park in Arizona, and another may be placed along the north rim. Sites are being chosen for plaques in Yosemite, Yellowstone and Zion National Parks and officials hope that unveiling ceremonies may also be held in these parks on July 4.

Plaques will be placed during the summer at Logan Pass in Crater Lake National Park in Oregon; Grand Teton in Wyoming; Rocky Mountain and Mesa Verde in Colorado; Lassen and Sequoia in California, and Mount McKinley in Alaska.

The plaques will be placed in the national parks by the Park Service. The Stephen T. Mather Appreciation is prepared to provide plaques for all the twenty-two parks and to provide and place one in each of the thirty-four national monuments included in the National Park System.

Placement of a plaque near Chinook Pass at the highest elevation of the Mather Memorial Highway, which crosses the Cascade Range east of Rainier National Park, is awaiting choice of a site, and arrangements are being made to put another in Mather Grove on Redwood Highway between Miranda and Dyerville, California.

Friends of Mr. Mather are to plant a grove of trees on the campus of the University of California, of which he was a graduate, and for this memorial also, at the request of officials of the university, a plaque will be provided.

MEMORIAL TO THOMAS ALVA EDISON

A design for an Edison Memorial Museum and eternal light at Menlo Park has been approved by the Edison Parkway Commission of Perth Amboy, New Jersey, and was presented by its chairman, Joseph F. Deegan, to the Edison Pioneers at their annual dinner on February 11 in New York City.

According to the plan, the building, designed by Colonel Hugh A. Kelly and Mr. John B. Peterkin, would cost $850,000. It would be circular in shape, measuring 180 feet across, and would be surmounted by a shaft reaching to a height of 175 feet. This would be surmounted by a translucent globe with the hemispheres indicated upon its surface and lighted internally and externally.

Not only would the building serve as a memorial and tribute to Mr. Edison, but as a museum to preserve for posterity objects associated with his life and works.

The plans show four entrances to the building. They lead into a rotunda which would be centered by an Edison statue. Murals depicting dramatic scenes from the inventor's life would cover the surrounding circular walls. In style the building would be a modern adaptation of the Greek, simple and dignified, but with an expression of rising strength in the shaft supporting the illuminated globe. The exterior would be of marble and limestone.

MEMORIALS

Former students in chemistry at the Johns Hopkins University, including non-graduates, have organized the Chemistry Alumni of the Johns Hopkins University with Dr. Henry N. Holmes, of Oberlin College, as president and Dr. Lyman C. Newell, of Boston University, as secretary. Two meetings are held each year, ordinarily at the time of the meetings of the American Chemical Society. At the last meeting it was voted to establish "The Remsen Memorial Collection," and a committee consisting of Dr. Lyman C. Newell, *chairman;* Dr. John C. Olsen, Polytechnic Institute, Brooklyn, New York, and Dr. E. Emmet Reid, of the Johns Hopkins University, was appointed to take charge of the matter. The committee at present is anxious to obtain early portraits of Dr. Remsen, autograph letters on scientific subjects and inscribed copies of the first, or an early, edition of his books, particularly books in a foreign language. Colleagues, associates, students and friends of Dr. Remsen who have memorabilia of this kind are requested to write the chairman of the committee, Dr. L. C. Newell, 688 Boylston St., Boston, Massachusetts.

The Medical Society of the District of Columbia held exercises on January 13, in memory of Dr. George Martin Kober, a former president of the society and for many years dean of the Georgetown University School of Medicine. Dr. Kober died on April 24, 1931. Addresses were made by Dr. Henry C. Macatee for the medical society; Rev. W. Coleman Nevils, S.J., for Georgetown University; Mrs. Ernest R. Grant, for the Washington Tuberculosis Association; Surgeon General Robert U. Patterson, for the medical corps, U. S. Army; Mr. George S. Wilson, for the board of public welfare of the District; Dr. Aleš Hrdlička, for the Anthropological Society of Washington. Dr. Arthur C. Christie, president of the society, was chairman of the meeting, which was open to the public.

In the presence of a distinguished gathering of American and French officials and airmen a monument was dedicated on January 30 to the memory of Wilbur Wright at the field of Pontlong, five miles from Pau, where Mr. Wright set up the first flying school in the world nearly a quarter century ago. The monument, executed by a Pau sculptor named Gabard, is in the form of a tall shaft with a bronze plaque. It was given by Mr. Frederick Prince, a New York banker, one of whose sons, an aviator, was killed during the war.

In commemoration of the one hundredth anniversary of the death of Laplace (in 1827) a memorial monument will be erected in the town of Beaumont, his birthplace. Dedication will take place in the summer of 1932.

RECENT DEATHS

John Wesley Young, Cheney professor of mathematics at Dartmouth College since 1911, has died at the age of fifty-two years.

Professor Harold Babbitt Smith, retired, for thirty-five years head of the department of electrical engineering at the Worcester Polytechnic Institute, a former president of the American Institute of Electrical Engineers, died on February 9, at the age of sixty-one years.

A correspondent writes: "William P. Headden, for a long time chemist of the Agriculture Experimental Station at Fort Collins, Colorado, died at his home at Fort Collins on February 5. He was professor of chemistry at the Colorado State Agricultural College since 1894, but later gave his entire time to the experimental station work and as such prepared many papers on investigations of soils, on plants, notably on the development of sugar in sugar beets, the formation of nitrates and their influence, etc. These led to many other papers. Dr. Headden was born in 1850 and therefore was nearly eighty-two years old. His work was of a very high character."

Gilbert Albion Bragg, general manager of The Koppers Research Corporation, Pittsburgh, Pennsylvania, died on February 2, at the age of forty years. He was a research chemical engineer who gained recognition as an authority on hydrometallurgy and later as a specialist in gas purification. Mr. Bragg held one of the first industrial fellowships at the University of Kansas, called the Robert Kennedy Duncan Fellowship No. 2, prior to the transfer of the Industrial Fellowship System to the Mellon Institute in Pittsburgh.

The death is announced in his eightieth year of Geheimrath Dr. Max Von Frey, professor of physiology at the University of Würzburg. Dr. Von Frey was especially known for his studies of sensation and the peripheral sensory forms. His last visit to the United States was in 1929 when he lectured in Minnesota and attended the International Congress of Physiology in Boston.

Professor Eduard Kaufmann, formerly ordinarius in pathology at the University of Göttingen, has died, at the age of seventy-two years.

A correspondent writes: "General Gustave Auguste Ferrié died in Paris on February 16, 1932, following an operation for appendicitis. General Ferrié held a very important position in the field of science, having been for many years member of the Institute of the Academy of Sciences of France, Commander of the Legion of Honor, correspondent of the Bureau of Longitudes, and Inspector General of the Military Telegraphic Service of France. He was president of the International Radio Congress held in Washington, D. C., in 1927. He was one of the delegates from France to recent conventions of the International Geodetic and Geophysical Union, and was chairman of the Committee on World Longitude Determinations. He perfected plans for the cooperation of many countries in the determination of longitudes around the world in 1928 for the purpose of testing the Wegener Hypothesis, and, at the time of his death, he was engaged on plans for a repetition of this work during the year 1933. He was born on November 19, 1868. In addition to being an eminent scientist, General Ferrié was a man of charming personality who had many scientific friends throughout the world. His death is a loss to science and to every one who had the pleasure of knowing and working with him."

SCIENTIFIC EVENTS

THE AMERICAN CHEMICAL SOCIETY

More than 1,000 men of science from all parts of the country will assemble in New Orleans from March 28 to April 1 for the eighty-third meeting of the American Chemical Society.

In several hundred papers and addresses to be presented from the laboratories of the nation's industries and universities, achievement in chemistry, which has gone on uninterruptedly during the economic recession, will be reported, according to an announcement by the president of the society, Dr. L. V. Redman, vice-president and director of research of the Bakelite Corporation, Bloomfield, New Jersey.

Speakers in a symposium on "Chemical Engineering Processes in the Oil Industry" under the chairmanship of Dr. R. T. Haslam, vice-president of the Standard Oil Development Company, will be Dr. Merrell R. Fenske, Pennsylvania State College; Alfred Fisher, Jacque C. Morrell and Gustav Egloff, Universal Oil Products Company, Chicago; Dr. Warren K. Lewis, Massachusetts Institute of Technology; Charles Allen Thomas and William H. Carmody, Thomas and Hochwalt Laboratories, Inc., Dayton, Ohio; J. B. Maxwell, Standard Oil Development Company, New York; S. N. Obryadchikoff and W. A. Peters, Jr., E. B. Badger & Sons Company, New York. Other speakers include representatives of the University of Michigan, the Standard Oil Company of Louisiana, Humble Oil and Refining Company, the Kellogg Company, the Standard Oil Company of Indiana and Alco Products.

Other sessions will deal with the progress of chemistry in the upbuilding of industry, with the problems of medicine and public health, and with developments in pure science, in agriculture and food, in chemical education, in gas and fuel, and in water, sewage and sanitation.

The opening event is a meeting of the council on Monday morning, March 28, President Redman presiding. On Monday afternoon there will be a general meeting, at which a group of special papers will be presented by men prominent in various fields. These include Mr. H. A. Gardner, president of the H. A. Gardner Laboratory, Washington, D. C., who will discuss "Tung Oil and its Production in the South" and Mr. Thomas Midgley, Jr., of the General Motors research staff, internationally known as the inventor of ethyl gasoline, will speak on "Fluorination."

Technical sessions will be held on Tuesday and Wednesday. The Division of Biological Chemistry, headed by Professor L. A. Maynard, of Cornell University, plans to hold a joint meeting on Tuesday afternoon with the Division of Agricultural and Food Chemistry, of which Professor Henry A. Schuette, of the University of Wisconsin, is chairman, and a symposium on "Pre-Medical Chemical Education" with the Division of Chemical Education, of which Professor O. L. Shinn, University of Pennsylvania, chairman, and the Division of Medicinal Chemistry, with Dr. Oliver Kamm, director of research, Parke, Davis and Co., Detroit, chairman. The Division of Biological Chemistry will also hold two general sessions.

The Division of Chemical Education, in addition to the joint meeting with the Division of Medicinal Chemistry and the Division of Biological Chemistry, has scheduled three half-day sessions, one being the meeting of the senate and standing committees. On Tuesday local teachers of chemistry will be invited to attend the meetings of the division and to be present at the luncheon.

The Division of Industrial and Engineering Chemistry, of which Professor D. B. Keyes, of the University of Illinois, is chairman, is sponsoring the oil symposium, in which the Division of Petroleum Chemistry, of which Cary R. Wagner, chief chemist of the Pure Oil Company, Chicago, is chairman, and the Division of Gas and Fuel Chemistry, of which J. D. Davis, research chemist of the United States Bureau of Mines, Pittsburgh, Pennsylvania, is chairman, will collaborate.

The Division of Petroleum Chemistry will also hold two half-day sessions for papers on other petroleum chemistry subjects. The Division of Medicinal Chemistry, besides its joint session with the Divisions of Biological Chemistry and Chemical Education, will hold one or more half-day sessions. The Division of Physical and Inorganic Chemistry, under the chairmanship of Professor H. H. Willard, of the University of Michigan, in addition to a joint symposium on "Adsorption" with the Division of Colloid Chemistry, headed by Dr. E. O. Kraemer, research chemist of the du Pont Co., Wilmington, Delaware, will hold two half-day sessions.

Other professional divisions of the society which have arranged programs for Tuesday and Wednesday and their chairmen include: *Cellulose,* Fred Olsen, director of research, Western Cartridge Company, East Alton, Ill.; *History of Chemistry,* Professor Lyman C. Newell, Boston University; *Organic Chemistry,* Professor Homer B. Adkins, University of Wisconsin; *Paint and Varnish,* Harley A. Nelson, research chemist, New Jersey Zinc Company, Palmerton, Pennsylvania; *Sugar,* W. L. Howell, chief chemist, Custom House, U. S. Treasury Department, New Orleans; *Water, Sewage and Sanitation,* A. S. Behrman, chief chemist, International Filter Company, Chicago.

Group dinners and luncheons, inspection trips to Louisiana industries and to points of historic interest, including the Vieux Carré, and a public address and a musical entertainment at the Roosevelt Hotel, where registration will be carried on beginning on Sunday, March 27, are among many features arranged by the General Convention Committee, of which Dr. C. E. Coates, of Louisiana State University, is honorary chairman.

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE Board of National Research Fellowships in the Biological Sciences, which includes within its scope the fields of anthropology, psychology, botany, zoology, agriculture and forestry, held its first meeting in 1932 on February 5 and 6, and made eleven reappointments and twelve new appointments for the academic year 1932–33, as follows:

REAPPOINTMENTS

For domestic study

S. H. Bartley—Psychology
G. W. Beadle—Agriculture
Wm. F. Hahnert—Zoology
E. W. Hopkins—Agriculture
T. L. Jahn—Zoology
M. L. Lohman—Botany
F. E. Meier—Botany
B. H. Schneider—Agriculture
B. F. Skinner—Zoology

For study abroad

H. H. Jasper—Psychology
F. K. Sparrow—Botany

NEW APPOINTMENTS

For domestic study

W. C. Bramble—Forestry
R. T. Hill—Zoology
I. T. Kelly—Anthropology
D. G. Marquis—Psychology
O. H. Mowrer—Psychology
M. M. Rhoades—Botany
G. B. Saunders—Zoology
G. L. Walls—Zoology
R. E. Zirkle—Botany

For study abroad

F. S. Howlett—Agriculture
M. J. Johnson—Agriculture
Albert Tyler—Zoology

A second meeting for further appointments for 1932–33 is planned for about April 28 and 29, and applications for consideration at this meeting should be filed not later than March 15. Information and application forms may be obtained from the Secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

WILLIAM J. ROBBINS,
Chairman, Board of National
Research Fellowships in
the Biological Sciences

HONORARY DEGREES CONFERRED AT THE BICENTENNIAL OF THE GEORGE WASHINGTON UNIVERSITY

TWENTY-THREE alumni of the George Washington University received honorary degrees at the Bicentennial Convocation on the evening of February 22. The doctorate of science was conferred on the following:

RAY SMITH BASSLER, M.S. 1903, Ph.D. 1905 (George Washington), A.B. 1902 (Cincinnati). Head curator of geology of the U. S. National Museum and professor of geology in The George Washington University, president of the Paleontological Society of America and vice-president of the Geological Society of America.

ALEXANDER WETMORE, M.S. 1916, Ph.D. 1920 (George Washington), A.B. 1912 (Kansas). Assistant secretary of the Smithsonian Institution in charge of the U. S. National Museum; biologist and author of scientific papers.

DANIEL KERFOOT SHUTE, A.B. 1879, M.D. 1883 (George Washington). Professor emeritus of clinical ophthalmology and formerly professor of anatomy, George Washington; author of articles and texts on anatomy and ophthalmology.

STERLING RUFFIN, M.D. 1890 (George Washington). Professor emeritus of medicine and consulting physician of the hospital of George Washington University.

CHARLES NAPOLEON MOORE, M.S. 1905 (George Washington), A.B. 1903 (Cincinnati), Ph.D. 1908 (Harvard). Professor of mathematics, University of Cincinnati.

JOSEPH FELS RITT, A.B. 1913 (George Washington), Ph.D. 1917 (Columbia). Professor of mathematics, Columbia University.

JOHN HOWARD DELLINGER, A.B. 1908 (George Washington), Ph.D. 1913 (Princeton). Physicist; chief of the Radio Section, U. S. Bureau of Standards since 1918; chief engineer, Federal Radio Commission in 1928.

The degree of doctor of engineering was conferred on:

DAVID ALBERT MOLITOR, B.S. in C.E. 1908, C.E. 1908 (George Washington). Structural engineer; designing engineer on Panama Canal; works connected with Saulte Ste. Marie Falls Canal and the channels through the Great Lakes, and other engineering projects; professor of civil engineering, Cornell University, 1908–11.

PHILANDER BETTS, E.E. 1903, Ph.D. 1914 (George Washington), B.S.-E.E. 1891, M.S. 1895 (Rutgers). Chief engineer, Public Utilities Commission of New Jersey; consulting engineer in electric light and power projects, directing the construction of some of the earliest electric lines.

AWARDS OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

THE annual dinner and award of the medals and prizes of the American Institute of Mining and Metallurgical Engineers took place on February 17 at the Commodore Hotel, New York City. The scientific sessions were held at the Engineering Society's Building. Mr. Robert E. Talley, retiring president, delivered the presidential address.

The William Lawrence Saunders Gold Medal, given for distinguished achievement in mining, was presented to Mr. F. W. Bradley, president of the Alaska Juneau Gold Mining Company, "for his skill and success in the creation of new wealth in the face of almost insuperable obstacles" in the operation of a gold mine on the coast of Alaska, which he made "a profitable enterprise although the ore carries less than a dollar per ton in gold."

The James Douglas Gold Medal for achievement in non-ferrous metallurgy was awarded to Professor C. H. Mathewson, of Yale University, for "his scientific contributions to the art of working and annealing non-ferrous metals."

Professor C. T. Eddy, of the Michigan College of Mining and Technology, received the Alfred Nobel Prize of $500 in cash for a "paper of particular merit contributed by a member of any of the four founder engineering societies before the author is thirty years old." Professor Eddy is only twenty-eight years old. His paper was on "Arsenic Elimination in the Refining of Native Copper."

The J. E. Johnson, Jr., award for meritorious researches in iron and steel was given to Mr. Ora E. Clark, of Hamilton, Ohio, who has "developed an exceptional insight into the reactions of an iron blast furnace without the usual aid of a university education, his theoretical training being gained at odd moments through a correspondence course and at night school."

Mr. Howard Scott, of the Westinghouse Company, East Pittsburgh, was the recipient of the Robert Woolston Hunt Prize for his paper on "transformational characteristics of iron-manganese alloys." Mr. Scott has also "developed a number of low-expansion and special-purpose alloys, and has carried on fundamental research in heat-treatment."

Insignia were presented by the retiring president, Mr. Robert E. Talley, to the new members of the Legion of Honor, class of 1882, who had completed fifty years' membership in the institute.

Mr. G. Temple Bridgman, who was the toastmaster, introduced Mr. Scott Turner, president for 1932. The following are the newly elected vice-presidents: Frederick M. Becket, vice-president, Union Carbide and Chemical Company, New York; Paul D. Merica, the International Nickel Company, New York. New directors are: Erle V. Daveler, treasurer, Utah Copper Company; Eugene McAuliffe, president, Union Pacific Coal Company; H. S. Mudd, consulting engineer, Los Angeles; J. B. Umpleby, petroleum engineer, Norman, Oklahoma, and Charles C. Whittier, consulting engineer, Chicago.

THE HAYDEN MEMORIAL GEOLOGICAL AWARD FOR 1932

THE Academy of Natural Sciences of Philadelphia announces that its committee on the Hayden Memorial Geological Award has selected Reginald Aldworth Daly, Sturgis-Hooper professor of geology at Harvard University, as the recipient of the 1932 award.

Professor Daly was selected by the committee in recognition of his outstanding work "in the study of igneous rocks, their genesis and the mechanics of their intrusion into the mountains of the Earth; his glacial-control theory of coral reefs, his work on the eustatic shift of oceanic level and his researches on the constitution of the Earth."

The committee on the Hayden Memorial Geological Award for 1932 consisted of Dr. Charles Schuchert, chairman, Dr. Henry Fairfield Osborn, Dr. Edgar T. Wherry, Dr. Henry A. Pilsbry and Dr. William Berryman Scott.

The Hayden Award was established with the Academy of Natural Sciences of Philadelphia in 1888 by Mrs. Emma W. Hayden, as a memorial to her husband, Dr. Ferdinand V. Hayden, a member of the academy, and director of the U. S. Geological and Geographical Survey in the early days of that organization.

The deed of gift provides that it shall be given "as a reward for the best publication, exploration, discovery or research in the sciences of geology and paleontology, or in such particular branches thereof as may be designated." From 1888 to 1900 the award consisted of a bronze medal and honorarium given annually, but in 1900 a modification of the deed of trust substituted a gold medal to be given every three years, for the previous annual award.

The Hayden Award will be formally presented at the meeting of the Academy of Natural Sciences of Philadelphia on April 19.

SCIENTIFIC NOTES AND NEWS

AT the exercises commemorating the fifty-sixth anniversary of the Johns Hopkins University on February 22, portraits of four past and present faculty members were presented to the university. Dr. Joseph S. Ames, president of the university, presided and Sir Wilmott Lewis, Washington correspondent of the London *Times*, was the principal speaker. Mr. George F. Baker, Jr., New York, presented a portrait of Dr. William H. Wilmer, since 1925 professor of ophthalmology in the school of medicine and head of the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital. The painting is the work of Frank O. Salisbury, London. Dr. William H. Welch, professor emeritus of the history of medicine, presented a portrait of the late Dr. William S. Halsted, first professor of surgery in the school of medicine. Dr. William S. Thayer, professor emeritus of medicine, presented a portrait of Dr. Frederick H. Baetjer, professor of clinical roentgenology. Both of these portraits are the work of Eric Haupt. Dr. William

Seifriz, professor of botany in the University of Pennsylvania, presented a portrait of Dr. Duncan Starr Johnson, professor of botany and director of the Botanical Laboratory and the Botanical Garden.

Professor R. E. Davis and Mr. H. E. Davis, of the University of California, have been awarded the Wason Medal for 1931 of the American Concrete Institute for the most meritorious paper dealing with research in the field of concrete and reinforced concrete. Professor Davis will receive the medal for himself and on behalf of Mr. Davis at a meeting on March 2 of the American Concrete Institute, of which he is a director, in Washington, D. C. At the same meeting he will speak on "The Hoover Dam and its Research Problems."

Mr. Willis H. Carrier, retiring president of the American Society of Heating and Ventilating Engineers, has received the first award of the F. Paul Anderson Gold Medal for scientific achievement in his field. Mr. R. A. Harding, of Buffalo, presented the medal at a banquet of the society held recently in Cleveland.

The 1931 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Mr. Giuseppe Faccioli, Pittsfield, Massachusetts, "for his contributions to the development and standardization of high-voltage oil-filled bushings, capacitors, lightning arresters, and numerous features in high voltage transformers and power transmission." The medal will be presented at the summer convention of the institute, which is to be held in Cleveland, Ohio, from June 20 to 24.

Awards of the Geological Society of London have been made as follows: The Wollaston Medal to Professor J. H. L. Vogt, of Trondhjem, Norway, in recognition of his researches on the mineral structure of the earth, and especially his pioneer work in the application of physical chemistry to the origin of igneous rocks and ore-deposits; the Murchison Medal, together with ten guineas from the Murchison Geological Fund, to Professor William George Fearnsides, in recognition of his researches in the Lower Paleozoic rocks of Wales, and other geological investigations; a Lyell Medal, together with £30, from the Lyell Geological Fund, to Mr. Henry Dewey, in recognition of his researches in the geology of the southeastern parts of England, more especially the Quaternary deposits of the London Basin, and a second Lyell Medal, together with £30, from the Lyell Geological Fund, to Dr. Maria Matilda Ogilvie Gordon, in recognition of her researches on the structure of the Western Dolomites.

The Dawson Williams Memorial Fund, established in 1928 in memory of the former editor of *The British Medical Journal*, which is awarded every two years, or at longer intervals at the discretion of the trustees, in recognition of work done in connection with pediatrics, has been given this year to Sir Robert Jones for his work in connection with the pediatric side of orthopedics. With the consent of the council, the prize will be presented by the president of the British Medical Association on the occasion of his presidential address on July 26.

Dr. Karl Herxheimer, professor of dermatology at Frankfort, has been awarded the Ehrlich-Weingert Medal by the medical faculty of the university.

The Mathematical Institute of the University of Moscow has awarded a prize of 750 rubles to L. S. Pontrjagin, member of the institute, for an article entitled "Uber stetige algebraische Körper" which appeared recently in the *Annals of Mathematics*.

Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden, has been elected president of the National Institute of Social Sciences, to succeed Mr. William C. Redfield, formerly Secretary of Commerce.

Dr. H. H. Sheldon, chairman of the department of physics at the Washington Square College of New York University, was elected president of the American Institute of the City of New York at a meeting held on February 12. Other officers elected were Dr. Otis W. Caldwell, *vice-president;* Dr. William Crocker, *secretary,* and Mr. Alfred Knight, *treasurer.*

Mr. H. Hobart Porter, of New York, president of the American Water Works and Electric Company and chairman of the board of the West Penn Electric Company, has been reelected chairman of the Engineering Foundation. Mr. George W. Fuller, of New York, has been elected first vice-chairman. Dr. C. E. Skinner, president of the American Institute of Electrical Engineers and assistant director of engineering of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, was named second vice-chairman. Mr. George D. Barron, mining engineer, of Rye, N. Y., and Mr. D. Robert Yarnall, manufacturer, of Philadelphia, and vice-president of the American Engineering Council, were elected members of the executive committee.

Sir Norman Walker, Edinburgh, has been elected president of the General Medical Council of Great Britain, succeeding Sir Donald MacAlister, who had been president of the council since 1904 and a member since 1889, a total service of forty-two years.

Dr. Emil Abderhalden has been elected president of the Academy of Sciences at Halle.

Dr. Jakob Früh, of Zurich; Professor Samuelowitsch, of Leningrad; Sir Francis Younghusband, of

London, and Dr. Robert Gradmann, of Erlangen, have been elected honorary members of the Geographical Society of Vienna.

THE *Journal* of the American Medical Association reports that Dr. Aldo Castellani, London, has accepted the position of professor of tropical medicine and head of the department at the Louisiana State University Medical Center, New Orleans. His appointment is for the year 1932–1933. Dr. Castellani resigned from a similar position at the School of Medicine of Tulane University in 1929 to devote full time to work in connection with a study of tropical diseases at the *Ross Institute of Tropical Medicine*, London, of which he was director.

MR. ELLWOOD WILSON, forester of the Laurentide Paper Company of Quebec, has been appointed a member of the faculty of the College of Agriculture of Cornell University in place of Professor Samuel N. Spring, who resigned recently to become dean of the College of Forestry at Syracuse University.

DR. HOWARD E. ENDERS, head of the department of biology in Purdue University and a member of the staff since 1906, has been made dean of the School of Science to succeed the late Dr. Richard B. Moore, who died early last year. Dr. Enders has been acting dean for some months.

DR. ALEXANDER PRIMROSE, dean of the faculty of medicine of the University of Toronto since 1920, retired on December 31. Dr. Primrose first came to the University of Toronto in 1889 as demonstrator in applied anatomy. He is president-elect of the Canadian Medical Association. His successor is Dr. John G. FitzGerald, professor of hygiene and preventive medicine, and director of the Connaught Laboratories.

DR. HUGH S. CUMMING has been appointed for another term of four years surgeon-general of the U. S. Public Health Service. The nomination was confirmed by the Senate on January 28. General Cumming was originally appointed to this position in February, 1920. On completion of his present reappointment he will have served continuously in this office for sixteen years.

DR. HARRY W. SCHOENING, who since September, 1931, has served as acting chief of the pathological division of the Bureau of Animal Industry, has been appointed chief of the division.

DR. E. H. SELLARDS has been appointed director of the Bureau of Economic Geology at Texas. Mrs. F. B. Plummer has been appointed consulting geologist and Joseph Hornberger, Jr., assistant geologist.

PROFESSOR A. O. LEUSCHNER, director of the student astronomical observatory of the University of California, has been elected to the executive committee of the national scientific society, Sigma Xi. He will fill the place made vacant by the election of Dr. Louis B. Wilson, of the Mayo Foundation, to the presidency.

DR. R. C. GIBBS, professor of physics at Cornell University, will be on sabbatical leave during the spring semester.

MR. MATTHEW W. STIRLING, chief of the Bureau of American Ethnology of the Smithsonian Institution, has started on foot to the country inhabited by the Jivaro Indians of Ecuador. Mr. Stirling's last communication came from Mendez, Ecuador, on the border of the Jivaro country, where he had been for the past three weeks. He stated that he was leaving the next day for a seven-day hike down the Paute River after which the expedition plans to work slowly down the Santiago and Maranon rivers to the Amazon and to Iquitos. Then they will strike out again along the Ucayali River, expecting to make their way to Lima. It is expected that Mr. Stirling will return to the United States some time in May.

MR. R. E. PETERSEN, manager of the mechanical division, Research Laboratories, Westinghouse Electric and Manufacturing Company, and Mr. T. S. Fuller, metallurgist, Research Laboratories, General Electric Company, have been appointed members of the Research Committee on Fatigue of Metals of the American Society for Testing Materials, and Mr. Stanton Walker, director, engineering and desearch division, National Sand and Gravel Association, has been appointed a representative on the joint committee on Concrete and Reinforced Concrete. He succeeds Mr. Cloyd M. Chapman, who resigned from this committee.

THE National Land Use Planning Committee, appointed by the Secretary of Agriculture, will consist of fifteen members, five to represent the Association of Land Grant Colleges; five the U. S. Department of Agriculture, three the Department of the Interior, and one each from the Federal Farm Board and the Federal Farm Loan Board. The committee held its first meeting at Washington on February 15. Members of the committee representing the Association of Land Grant Colleges are: Provost A. R. Mann, of Cornell University; President H. A. Morgan, of the University of Tennessee; President H. L. Shantz, of the University of Arizona; Dean C. B. Hutchison, of the University of California, and President F. D. Farrell, of Kansas State College.

PROFESSOR P. DEBYE, head of the Institute for Experimental Physics at the University of Leipzig, is giving a series of lectures on "X-Ray Scattering and Molecular Structure" in the department of physics at the Massachusetts Institute of Technology. Professor

Debye will be Scott lecturer at the University of Cambridge for 1932.

SIR ARTHUR NEWSHOLME, of Birmingham, England, formerly principal medical officer of the local government board of England and Wales, will lecture this spring at Harvard University on preventive medicine.

DR. J. C. MEAKINS, professor of medicine and director of the department of medicine at McGill University, physician in chief to the Royal Victoria Hospital, Montreal, has accepted an invitation to lecture at the Medical School of the University of California in San Francisco. These lectures will open on March 11 and close on April 7.

DR. HENRY K. BENSON, chairman of the Division of Chemistry and Chemical Technology of the National Research Council, delivered the 1932 Alpha Chi Sigma Public Lecture in chemistry at the University of Virginia on February 11. His subject was "Cellulose and Allied Industries."

MR. WILFRED TROTTER took as the subject of the Hunterian oration "The Commemoration of Great Men." The lecture was delivered before the Royal College of Surgeons of England on February 15. A banquet was held in the evening at the college.

MR. J. B. S. HALDANE, Fullerian professor of physiology, is giving a course of five lectures on "Heredity in Man" at the Royal Institution, London.

THE annual meeting of the American Medical Association will be held in New Orleans from May 9 to 13.

THE sixteenth annual meeting of the American College of Physicians will be held at the University of California early in April.

THE summer session of the Hopkins Marine Station, the Marine Biological Laboratory of Stanford University, at Pacific Grove, on the shore of the Bay of Monterey, will open on June 23, lasting until August 31. Courses will be given by Dr. Felix Eugen Fritsch, professor of botany in the University of London, and Dr. Gilbert Morgan Smith, of Stanford University, on the morphology and taxonomy of the algae; by Dr. Cornelis Bernadus van Niel, formerly of Delft, Holland, now of Stanford University, on microbiology, and by Dr. Harold Mestre on plant physiology and on physico-chemical biology. Properly qualified students, interested in individual fields, will be admitted to the laboratories for advanced work and research. Application for accommodation should be made early, as the space in the laboratory available for summer work is limited.

THE College of Puget Sound, Tacoma, Washington, has recently received $150,000 from the estate of Leonard Howarth, and $50,000 from a friend in Portland, Oregon. These gifts have enabled the college to pay the debt on the new science building, and on February 19 it will be dedicated as the Leonard Howarth Hall. The building is 57 by 152 feet, of reinforced concrete faced with brick and has three and one half stories. It houses the departments of biology, chemistry, domestic science, geology and physics. These gifts make it possible for the college to receive $135,000 from the General Education Board of the Rockefeller Foundation, completing a gift of $250,000. The college endowment is now about $1,250,000. Its plant, valued at $700,000, is entirely free from debt.

THE Mineralogical Society of America is compiling a list of mineral collections, public and private, in the United States and Canada, the intention being to publish this information in the form of a regional directory in *The American Mineralogist*. Curators of collections and mineral collectors are asked to send their names and addresses, and some data regarding the nature of their collection, their origin, and when they can be seen by visitors. The society would also welcome information regarding other collections known to the correspondents, which they consider should be included in the directory. Since the success of the survey being made will very largely depend upon such cooperation, an earnest appeal is made for full, complete and prompt replies. Correspondence should be addressed to Samuel G. Gordon, Academy of Natural Sciences of Philadelphia, Logan Square, Philadelphia, Pennsylvania.

The Museum Journal reports that the first new unit of the east wing of the California Academy of Sciences has been completed and the departments of entomology and fishes and the administrative offices have moved to their new quarters. The habitat groups in the Simson African Mammal Hall are now being installed under the direction of Frank Tose, chief of exhibits, with the assistance of John Adams and Jenness Richardson, mammal taxidermist; Stuart Rowley, Marietta Edwards and Richard Cayzer, installation and accessories; Cecil Tose and William Hayden, assistant preparators, and J. M. Barclay, general assistant. Hanson Puthuff, of Los Angeles, California, is expected to paint the first backgrounds. The opening of the hall to the public is planned for December, 1932. The main hall contains space for twenty-four groups, all of which will be displayed under artificial light.

SCIENTIFIC work, according to a summary given out by Science Service, in the Bureau of Geological Survey, will be curtailed in 1932–33, as a result of action first by the Budget Bureau and second by the House Committee on Appropriations. For the entire bureau there is a decrease of almost $1,500,000 in appropriations, compared to 1931–32. For some years the Geological Survey has been engaged in making a topographic map of the United States. It is expected that the Congress will follow recommendations of the committee in cutting this work down by at least $100,000 more than suggested by the budget, which was a $164,000 decrease. Geologic surveys, for which $400,000 was asked (the same as the amount appropriated for 1931 and 1932) will probably be cut $50,000; likewise fundamental research in geologic science, for which $100,000 was asked. Volcanologic surveys will probably be cut down from $35,000 in 1931–32 to $21,000. The main volcanologic observatory of the United States is in the Hawaiian Islands on the great volcano of Kilauea. Investigation of the mineral resources of Alaska, an item for which it was hoped there might be $84,500, the same as in 1932, was reduced by $17,000. Gaging streams and determining water supply of the United States has been cut $119,500. It had been estimated that $719,500 would be required. Other items suffering cuts are the classification of lands, the printing of geologic maps, and investigations of minerals on public lands and naval petroleum reserves.

In order to achieve a broader representation of sportsmen and conservationists upon the Advisory Board, Migratory Bird Treaty Act, and to obtain a large measure of local cooperation in the problems of conservation and enforcement, a reorganization of the board is being planned by Secretary of Agriculture Hyde. As a means of securing more direct regional representation on this board, the states have been tentatively divided into ten groups. These groups are so arranged as to give consideration to such matters as relative density of population and dissimilarity of conditions affecting migratory birds, as well as the various interests of those who are concerned in their welfare. A majority of the members of the board will be selected from these groups in cooperation with and upon the recommendation of the state conservation officials. The advisory board is organized for the purpose of assisting the federal authorities in a solution of regulatory problems in connection with the federal administration of the migratory bird resource. When constituted, it will be requested to study and recommend definite policies upon all questions affecting the interest of the sportsmen and conservationists of the United States and falling under the jurisdiction of the Biological Survey, U. S. Department of Agriculture. Such subjects as length of seasons, bag limits, shooting restrictions, zoning, measures for increasing the supply of both upland game birds and water fowl and measures for conserving the existing supply will be submitted to it.

DISCUSSION

THE PROCESS OF GIORDANO BRUNO

In his presidential address to the Astronomical Section of the American Association for the Advancement of Science published in Science of January 8, 1932, President D. W. Morehouse says: "Suggestions were heard on every side that such views should be forcibly repressed, and some of its advocates, for example, Bruno, were condemned to death and burned at the stake in 1600. As history records, the second martyr of the Jesuits was harassed and persecuted solely for his adherence to the Copernican system." This statement is erroneous.[1] The external data of Bruno's life are the following:

Bruno was born in 1548 in Nola, a small town near Naples, entered the Dominican order at the age of 14 or 15 years, and left the order in 1576, travelled then extensively in Italy, France, Switzerland, England and Germany. He returned to Italy, was accused in Venice, arrested and tried there in 1592 before the Inquisition. In 1593 he was extradited to Rome, where his process lasted until 1600, in which year he was condemned and burned at the stake. The question now arises as to what the reasons for this condemnation were.

The documents of the Venetian process were first published by Berti. A more recent book is by Father Luigi Previti, S.J., "Giordano Bruno," Prato, 1887.[2] The documents of the Venetian process contain first the denunciation by Giovanni Mocenigo on the grounds of heresies concerning the Trinity, the sacraments, the transmigration of souls, the existence of an infinite number of worlds and the eternity of the world, besides teaching conjuration (I am not giving the complete list). After a number of purely formal documents we find then a complete record of the interrogation of Bruno. This record gives the impression of stenographic accuracy; the questions of the court apparently being written down beforehand in grammatically correct style, while the answers of the accused show all the characteristics and repetitions of extemporaneous speech. One can judge the points which were used in the indictment from the questions which were asked. They concern points in the dogma of the Trinity, incarnation and the sacraments. He was questioned whether he had said that Christ and the Apostles were magicians (or sorcerers?), whether he believed in the migration of souls. He was asked, and confessed, that he had taught that fornication was a small sin and had condemned the church in forbidding it. He ("the martyr of science") was accused of defending conjuration. Furthermore, he was questioned about his associations in Geneva and England (where he had written a book "Spaccio della Bestia triofante"—"Expulsion of the Triumphant Beast"—interpreted as aimed at the Church). In the whole interrogation there are only three places which are even slightly bearing on the question of natural science. At the beginning of the interrogation, upon being asked whether he confesses errors, he himself said that he had taught the existence of an infinite number of worlds and that the earth was one of the stars. But this point was not taken up in the questioning, and is not contained in the summing-up of his errors which is given by the court (Previti, p. 351).

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[1] Sir James Jeans says also in his book, "The Universe Around Us," that Bruno was condemned because of his advocacy of the Copernican theory.

[2] I am indebted to Father Gerald Walsh, professor of history at Woodstock College, for drawing my attention to this book, and putting it at my disposal.

The second point was on determinism and was contained in the question whether he had denied Providence (p. 357). Finally, he had at the beginning handed over a list of all his published books. He was asked why this did not contain the book "cena delle ceneri." He answered that this book, published in England, treated of the motion of the earth. No further mention is made of its contents—they had not been questioned (p. 358). Nowhere is there any mention of the Copernican theory in the whole process. In the request for extradition which the Papal Nuncio addressed to Venice, Bruno is accused of his associations in Geneva, France and England, and of heresies concerning the dogma of the incarnation and of the Trinity. No mention whatsoever is made of any physical theory.[3]

The acts of the Roman process are not published, except a few purely formal ones, but as the punishment is one reserved for relapsed heretics one must assume that it went over the same ground as the process of Venice. There do exist documents to show that here too there was no mention of Copernicus' theory. There exists a letter of Gaspare Scioppio (Kaspar Schopp) to Conrad Rittershaus. Schopp[4] was an eye witness of the execution and says that he had heard the sentence proclaimed. According to him, Bruno was condemned because of heresies against the sacraments, the incarnation, because of teaching the transmigration of souls, the innumerability and eternity of the worlds, because of his denial of the divinity of Christ and the statement that Christ and the Apostles were magicians. It is true that the authenticity of this letter is denied by some; however, in a book published eleven years later, he says that Bruno was executed because he did not want to abjure his pagan acceptance of "portenta et monstra" (apparitions), and his statements against Christ and the Apostles (Previti, p. 211).

However, there is another argument which seems to me quite independent of the documents and quite convincing that the condemnation of Bruno had nothing to do with Copernicus' theory, and that is a simple comparison of the dates. Bruno was tried in 1592 and executed in 1600. In 1611 Galileo came triumphantly to Rome, and it was not until 1615 that proceedings against him were begun. It is quite clear that if there had already been proceedings on account of this theory, and if Bruno had been condemned to the stake in 1600 for it, the adversaries which Galileo had before 1615 would have behaved quite differently and would not have failed to point out that he was defending the theory on which the Inquisition had already acted. Galileo himself, of course, would also have behaved quite differently in this case.

As to President Morehouse's remark, "the second martyr of the Jesuits," it might be said that on the Roman tribunal of sixteen judges there were 12 seculars, 3 Dominicans (Bruno's own order) 1 other monk and 1 (!) Jesuit.

Bruno might perhaps be called a martyr to Pantheism, to Buddhism, to Unitarianism, but surely not to science.

K. F. HERZFELD

THE JOHNS HOPKINS UNIVERSITY

A SMALL INSECT WHICH STINGS SEVERELY

IN November, 1925, a minute black hymenopterous insect, scientifically known as *Epyris californicus* (Ashmead), was first sent to the University of California by a farmer at Clarksburg, Yolo County, California, with the statement that it had severely stung a child several times and was the cause of severe pain and considerable inflammation. Due to the fact that the insect in question is barely over 5 mm in length, the idea of its being so formidable was doubted. Specimens forwarded to the Bureau of Entomology were determined as the above by S. A. Rohwer, who stated that they were the only other ones seen up to that time which agreed with the original types.[1] Although informed that probably some other insect was responsible for the injuries to the child, the farmer insisted that he had sent the real culprit.

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[3] It will be found that this presentation agrees with the one in T. L. MacIntyre, Giordano Bruno, London, 1903, although this author is very favorable to Bruno.

[4] This letter can be found in Previti's book on page 440.

[1] W. H. Ashmead described the species as *Mesitius californicus* from several specimens taken in California

In October, 1928, more specimens of the same insect were received from Davis, California, with a similar claim that they were stinging children, and particularly a small infant in its crib. To make sure of the exact identification, specimens were again sent to the Bureau of Entomology and determined as the above by A. B. Gahan. By this time I was beginning to suspect that this small parasite was assuming a new rôle, but there was no way to prove or disprove the suspicions. Additional information concerning this interesting insect was received on October 16, 1930, from Frank B. Hopkins, a teacher of biology in the Esparto Union High School, Esparto, California, who wrote as follows: "I am sending a box containing a little vial in which are four or five little Hymenoptera. Will you please tell me what you think they are? They were handed to me by a lady here, who is frequently stung by them so badly they make her ill. The first time she was stung (she was alone), she went into a heart attack and nearly died. She managed to call help, however, and when the physician came he administered strychnine. She continues to keep the drug by her, but usually applies alcohol to allay the sting. The house is surrounded by large walnut and Mission fig trees. This is the only case of the kind in the community of which I can learn."

A few days later another case was reported at Woodland, California, by an attending physician, who submitted specimens to Dr. Tracy I. Storer, of the University of California at Davis, which later came into my hands for verification.

All these cases were reported from a comparatively small area in Yolo County and to date no such reports have come from any other county in California, nor have I noted similar records from any other state or country.

The evidence at hand indicates beyond doubt that *Epyris californicus* stings humans, both young and adult; that it is able to inflict considerable pain and inflammation; that its activities are at present quite restricted as to localities; and that its attacks are sporadic and uncommon. Concerning the life history and habits of this particular species, beyond its propensity for stinging, absolutely nothing is known. According to Imms,[2] "*Epyris* stings Tenebrionid larvae and lays a single egg on each." In California Tenebrionid beetles are abundant and perhaps furnish the natural food supply for this hymenopterous parasite.

E. O. ESSIG

UNIVERSITY OF CALIFORNIA

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in his Monograph of the North American Proctotrypidae, Bul. 45, U. S. Nat. Mus., pp. 65–66, 1893. It is now placed in the family Bethylidae, superfamily Proctotrupoidea.

[2] A. D. Imms, "A General Text-book of Entomology" (Dutton, N. Y., 1930), ed. 2, p. 574.

HAMIVOROUS FISH

IN the November 20, 1931, issue of SCIENCE, Mr. C. T. Hurst directed attention (on page 515) to "a quite curious case of gastric erosion of a fish hook that had been swallowed by a fish."

Upon its appearance, I showed this fish story to Dr. Charles Reitell, the well-known ichthyophile and the author of "Let's Go Fishing." He said immediately: "Any one who fishes for pickerel as much as I do finds it quite a common experience to discover old hooks in the anatomy of this fish. Because of his sharp teeth, he often saws off the line or gut. More than once I have found trebled hooks deeply imbedded in the throat of a pickerel which, with the very slightest pressure, were crushed."

The experience of Dr. Reitell, then, confirms in general Mr. Hurst's report.

W. A. HAMOR

MELLON INSTITUTE

RELATIONS BETWEEN FUNDAMENTAL PHYSICAL CONSTANTS

A NUMERICAL relation has been found between the fundamental physical constants shown below and the velocity of light. This relationship is of such a nature that the constants can be calculated from a single equation $1/2\pi c = C^{12}$ and the power of the velocity of light shown, provided the decimal point is ignored. A complete solution of the relation given, enabling the decimal point to be properly placed, has not yet been found. It is, however, not possible that any merely accidental agreement could produce the numerical agreement shown below. The facts concerned will be presented in a more technical paper.

CALCULATION OF FUNDAMENTAL PHYSICAL CONSTANTS

		Observed	Calculated
C	C	$(2.99796 \pm 0.00004) \times 10^{10}$	2.99960
C^2	m_o	$(8.994 \pm 0.014) \times 10^{-28}$	8.99761
C^6	$1/k$	$(7.294 \pm 0.0074) \times 10^{15}$	7.28415
C^8	h	$(6.547 \pm 0.008) \times 10^{-27}$	6.55402
C^{14}	ε	$(4.770 \pm 0.005) \times 10^{-10}$	4.77401
C^{34}	m_P	$(1.6610 \pm 0.0017) \times 10^{-24}$	1.66014
C^{36}	$\frac{1}{G}$	$(1.5006 \pm 0.0005) \times 10^{7}$	1.49373

π = Geometrical Constant; C = Velocity of light; m_o = Mass of electron; m_P = Mass of proton; h = Planck's Constant; ε = Electronic charge; G = Gravitation Constant; k = Boltzmann Constant.

J. E. MILLS

UNIVERSITY OF SOUTH CAROLINA
JANUARY 26, 1932

SOCIETIES AND ACADEMIES

THE NORTHWEST SCIENTIFIC ASSOCIATION

THE members of the Northwest Scientific Association assembled for their eighth annual meeting at Spokane, Washington, on December 29 and 30, 1931. Notwithstanding the anticipation that the attendance might be reduced, over 170 members of the association were present, in addition to numerous guests. This constitutes the largest attendance yet recorded at any annual meeting, being an increase of approximately 18 per cent. over that of the largest previous meeting.

The meetings were presided over by President Ernest O. Holland, of the State College of Washington, president of the organization for the year 1931. At the opening meeting, on December 29, President Homer L. Shantz, of the University of Arizona, was to deliver an address on the subject, "The Vegetation of the United States and its Relation to Agriculture." Unfortunately, President Shantz was unable to leave Arizona because of a special session of the legislature. In his absence his place was filled by Dr. E. F. Gaines, of the State College of Washington. Dr. Gaines related impressions of Russian scientists and the Russian experiment stations, gathered during a year of study and travel in Europe in 1930–31. On the same day a broadcast through the courtesy of the National Broadcasting System was to have been given under the auspices of the association, the speaker being Dr. George D. Louderback, of the department of geology of the University of California. Due, however, to a severe storm, wire connections were suspended and the broadcast was cancelled.

In addition to the general sessions, section meetings were held by the following sections: Botany-Zoology, Chemistry-Physics, Education-Psychology, Engineering, Forestry, Geology-Geography, Medicine-Surgery and Social Science. On the morning of December 30 a joint session of several of the sections was held, the symposium topic being, "Climate and its Relation to Science in the Northwest."

At the general meeting on December 30 the association passed resolutions commemorating the service to science of Dr. W. J. Spillman, a former member of the faculty of the State College of Washington, later a nationally known figure in the field of agricultural economics, and of Dr. B. L. Steele, a member of the association and of the faculty of the State College of Washington at the time of his death.

A resolution was also passed requesting that the members of the agricultural committees from the Northwest in the House and Senate direct their attention to the menace to agriculture arising from soil erosion.

At a council meeting of the association the officers and councilors decided to make the coming meeting of the Pacific Division of the American Association for the Advancement of Science, to be held at Pullman, Washington, from June 15 to 18, a special meeting of the Northwest Scientific Association and to cooperate in every way possible to make the meeting successful. To this end President Holland appointed a contact committee from the association consisting of the following members: C. C. Todd, *chairman*, J. W. Hungate, H. B. Barss, John W. Finch, L. K. Armstrong, Charles H. Clapp, F. A. Thomson, Alfred Atkinson, I. N. Madsen and R. E. McConnell. The secretary reported that the association is now connected with the American Association for the Advancement of Science, having affiliated as an academy in April, 1931.

The following officers will serve for 1932:

President: Ivan C. Crawford, dean of the school of engineering of the University of Idaho, Moscow, Idaho.

Vice-President: T. C. Spaulding, dean of the School of Forestry of the State University, Missoula, Montana.

Secretary-Treasurer: J. W. Hungate, State Normal School, Cheney, Washington.

Councilors: E. E. Hubert, School of Forestry, University of Idaho, Moscow, Idaho; Charles H. Clapp, State University, Missoula, Montana; H. N. Putnam, U. S. Blister Rust Service, Spokane, Washington; E. F. Gaines, Washington State College, Pullman, Washington; and G. D. Schallenberger, State University, Missoula, Montana.

Trustees: F. A. Thomson, School of Mines, Butte, Montana; Thomas Large, Lewis and Clark High School, Spokane, Washington, and L. K. Armstrong, 704 Peyton Building, Spokane, Washington.

E. E. Hubert, editor of *Northwest Science*, the official publication of the association, was reappointed for the year 1932. The assistant editor will be A. L. Anderson, of the department of geology, University of Idaho, Moscow, Idaho.

The following were elected as chairmen of the various sections:

Botany-Zoology, H. B. Stough, University of Idaho, Moscow, Idaho; *Chemistry-Physics*, G. L. Luke, University of Idaho, Moscow, Idaho; *Education*, C. I. Erickson, State College, Pullman, Washington; *Engineering*, H. H. Langdon, State College, Pullman, Washington; *Forestry*, S. N. Wyckoff, U. S. Blister Rust Control, Spokane, Washington; *Geology-Geography*, John W. Finch, University of Idaho, Moscow, Idaho; *Medicine-Surgery*, Dr.

D. Hartin, Old National Bank Building, Spokane, Washington; *Social Science*, T. S. Kerr, University of Idaho, Moscow, Idaho.

J. W. Hungate,
Secretary-Treasurer, Northwest
Scientific Association.

FOURTH ROUND TABLE OF CATHOLIC SCIENTISTS HELD IN NEW ORLEANS

Forty-one priests, nuns and lay delegates, representing twenty-four Catholic educational institutions in the United States and Canada, attended the round table for Catholic scientists and teachers of science which was held in New Orleans, on December 28, 1931. The meeting was held at Loyola University, following a luncheon at which the president and faculty of the university acted as hosts.

The round table is an informal group of research workers and teachers which originated at the American Association meetings in New York City in 1928. It started with only six members, but each succeeding year has interested a steadily increasing number in attending the A. A. A. S. meetings. Encouragement of productive scholarship, as distinct from the purely absorptive, by Catholics in the field of natural science is the main object of the round table. Its sessions are held during the association meetings, since its members feel that, inasmuch as science in general and scientific research in particular are neutral as regards religious belief, the formation of anything that savored of a separate Catholic body would be superfluous and, given the hazard of misinterpretation of its aims by Catholics and non-Catholics alike, apt to do more harm than good.

In order to further its main objective the round table has sponsored discussion groups, membership in the A. A. A. S. and its associated societies, shorter teaching hours and more research equipment for members of science faculties, and a continued program for encouraging worth-while students to make science teaching and research a life career in preference to other overcrowded professions.

More than three hundred names, including those of several bishops and college officials, listed in the membership of the round table, testify to a healthy interest in its activities. Reports of past sessions will be freely supplied by the writer, the secretary for the present year.

A. M. Keefe

St. Norbert College,
West De Pere, Wisconsin

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A ROTARY MYOGRAPH

Requiring several myographs for student laboratory use, the simple apparatus as sketched was designed and proved satisfactory in use.

The equipment shown presents several advantages over those listed in various catalogs at prices of $200 and more. The rotary myograph as pictured requires no casting patterns and can be made from material usually found in physiological or biological laboratories. Other advantages besides the low cost are: The writing surface is nearly twice as long and is fully twice as wide as those found on the expensive machines. The principal wearing surface has ball bearings in place of friction rods. The weight of the entire machine is about one tenth and the storage space required about one fourth of the heavier machines. The noise of operation is no greater and the speed of the drum does not vary with uniform spring tensions. The speed of the writing surface may be adjusted over a wider range, while speeds of one thousandth of a second per centimeter have been attained; this is at least ten times that required for the usual student use in studies on speed of the nerve impulse, determination of latent period, stimuli summation, refractory period studies, reaction time studies and others.

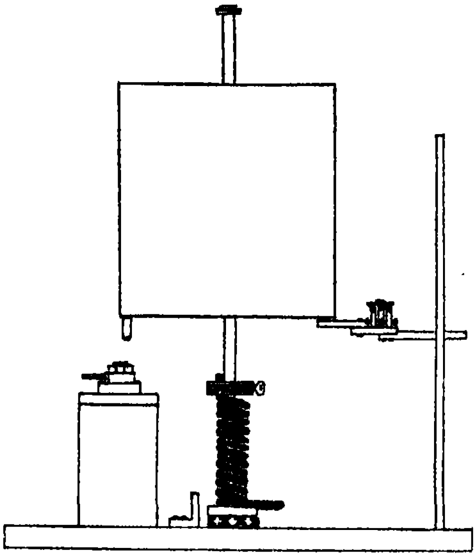
The drum can be removed without releasing catches, and the ordinary kymograph paper may be used. Any laboratory using kymographs may make the drums of these serve double duty without having to invest funds in expensive equipment.

Material and Construction

Ordinary aluminum drums of the Harvard type were used, although others would serve as well. Center rod ringstands may be employed for the base and drum axis. Other material, such as brass plate, spring wire, machine screws and nuts, fiber sheets and cheap quilt frame clamps, are usually to be found in the stock of most schools or can be readily obtained.

The base plate may be a center support ringstand base or heavy iron plate, the rod which serves as the drum axis must be a close but free fit. Cased ball bearings obtainable at cycle shops, placed as shown, reduce friction and make for smooth action, although these are not essential to a good working assembly. The set shows a support rod for the switches, but these can as well be placed on adjacent ringstands.

A fairly strong spiral spring is essential for the driving unit; these may be obtained from old bedsprings or from heavy door-springs. The ┘ shaped spring stop may be made of brass or may be a short bolt through the base plate. The collar with wing nut



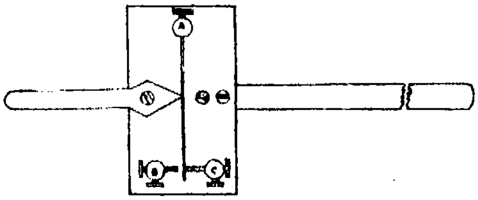
SIDE VIEW

Fig. 1

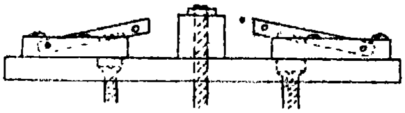
makes the upper end of the spring fast to the hollow drum support and allows for spring tension adjustments.

The switch assembly is self-explanatory, and either spring brass or steel may be used for the vane. Contact points may be platinized if desired.

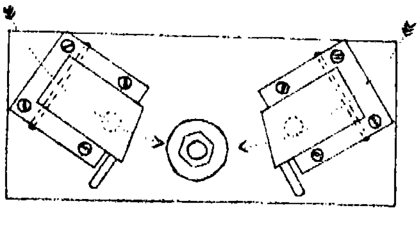
The most difficult part of the assembly to make is the drum catch and release. Figs. 3 and 4 give a top and side view of this in proportions. One fourth inch brass plate is used to cut out the U-shaped retainers for the catches. These catches are normally held up by spiral brass springs placed over the set in bolt heads, the shanks of which run to the base plate. Quarter inch brass plate is used to mount the catches and central bumper post on, the entire catch and release assembly is mounted on a wooden block which is firmly attached to the base plate by the three bolts. The center bolt is fitted with a rubber stopper to reduce noise and prevent backlash.



SWITCH



DRUM CATCH AND RELEASE
SIDE VIEW



TOP OF CATCH AND RELEASE

Figs. 2, 3 and 4

The catch and trip pin on the drum is a brass machine screw, this is covered by fiber tubing, except at the wearing edge. The dotted arrow in Fig. 3 shows the path of the trip pin. By proper placing of the switches this trip pin will cause either make or break stimuli to occur. Since the switches function either right side up or inverted stimuli may be placed as close together as wanted or even be made simultaneous by placing one switch over the other.

In use the spring tension is adjusted to give a drum speed of approximately one centimeter per hundredth of a second. The drum pin is held by the catch and release is obtained by depression of the small pin projecting from the catch. If the base plate is not heavy enough to prevent jump of the assembly in use, a small quilt frame clamp such as found in dime stores may be used to fix the assembly to a desk top. Set screws must be employed to firmly fix the drum to its hollow support rod. All kymograph drums do not have these, but they are easily attached.

Seward E. Owen
Department of Pharmacology
and Physiology,
University of Utah

MULTIPLE LABORATORY INCUBATOR FOR THE BIOLOGICAL STUDY OF CHICK EMBRYO

In former publications in this journal,[1] and elsewhere,[2,3] I have emphasized that the accurate control of the most important physical factors, such as temperature, humidity and composition of air, is absolutely indispensable in the experimental incubation of hen's eggs. The importance of such control in all physiological and physicochemical studies of the embryo is obvious when daily observations have to be made on a small number of various individuals.

The laboratory incubator previously described[1,2,3] had already given excellent service by its accuracy in the control of the various physical factors and by its adaptability to a wide range of experimentation. With this incubator we were enabled to obtain very uniform and conclusive data on some phases of the embryonic growth,[4] metabolism and mortality, and also on the physicochemical changes in the egg contents under standardized,[5,6] or "normal" and adverse conditions of incubation: humidity,[2,7] composition of air,[2,8] and temperature.[9]

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[1] A. L. Romanoff, Science, 69: 197–198, 1929.

[2] A. L. Romanoff, *Cornell Univ. Agr. Expt. Sta. Memoir*, 132: 1–27, 1930.

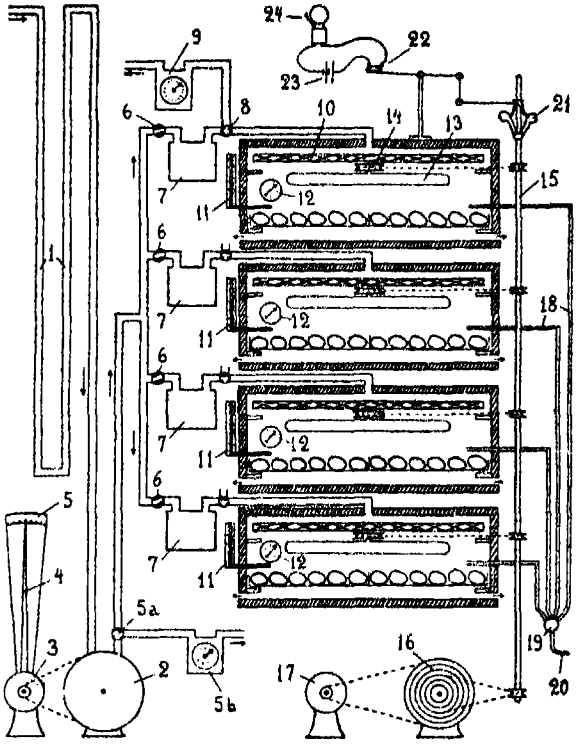
[3] A. L. Romanoff, *Jour. Morph. and Physiol.*, 50: 517–525, 1930.

However, our experience showed that the above-mentioned incubator, being of a single-compartment only, is not efficient enough. Only a few experiments can be carried on during the natural hatching time, which is limited to about six months, that is, approximately from December to July. Secondly, when the results of several experiments are to be used for comparison, this incubator does not eliminate seasonal variation in the hatching quality of eggs; but it is a well-known fact that the average hatching of eggs varies throughout the season.

Therefore, in order to eliminate the influence of the season on the hatching quality of eggs and also to increase the efficiency of experimental work, we soon saw the need of a multiple, or of a several-compartment laboratory incubator, to carry on several experiments simultaneously. A commercial sectional incubator (vertical type, four compartments) was completely remodeled and all necessary special equipment was installed,[10] as shown on the accompanying diagram.

Each compartment (capacity 152 eggs) of the new multiple incubator is equipped independently with electric devices which allow wide range in the control of temperature, humidity, supply of fresh air, rate of mixing of air and turning of eggs. Beside that, a special provision is made for sampling and transferring of air to the laboratory for analyses. Accuracy in the control of temperature and humidity has been attained within an average, ± 0.2° C. and ± 1.0 per cent. relative humidity.

When the incubator is in operation, outdoor fresh air, regardless of atmospheric conditions, may be brought continually through the long pipe (1), in which it is heated to room temperature, by means of the blower (2), driven by the variable-speed motor (3). The speed of the motor is regulated by the control lever (4), a point of which is laid against the scale (5). The total rate of air flow is measured at the three-way valve (5a) by the gas meter (5b); then air is distributed at will by means of the valves (6), conditioned in respect to humidity in the humidifiers (7), and the actual amount of it in each compartment is determined at the three-way valves (8) by the gas meter (9). Indrawn air strikes the electric heater (10), which is controlled by a thermostat with mercury switch. The temperature is recorded by the right-angle thermometers (11) graduated to 0.2° C., and the humidity recorded by the precision hair hygrometers (12). Air in each compartment is evenly distributed over the hatching eggs by the air mixers (13), which have the pulleys (14) connected with the shaft (15) and, through the countershaft (16), to the low-speed electric motor (17). At any time samples of air may be drawn through the sampling tubes (18) and the selective valve (19) to the outlet tube (20) leading to a laboratory analysis apparatus. In order to prevent any accident from an electric power shut-off or disorder in circulation or mixing of air, special electric alarm systems are connected with the living quarters of the operator. The circulation of air is under the control of a system similar to that previously described;[2] but the mixing of air is controlled by the governor (21) connected with the mercury switch (22), the battery (23) and the electric bell (24).



The efficiency of the above-described laboratory incubator, as compared with the old incubator, is obvious. It provides: (1) greater accomplishment in the experimental time, which is limited to the natural hatching season of the year; (2) simplicity in the routine work, due to many automatic devices; (3) uniformity in the seasonal quality of hatching eggs in each group of experiments; and (4) results of several experiments suitable for comparison, particularly in the study of the effect of various environmental factors on the developing embryo.

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[4] A. L. Romanoff, Science, 60: 484, 1929.

[5] A. L. Romanoff, *Alabama Polytech. Inst. Bul.*, 25: 45–49. (Poultry Sci. Assn. Proc., 21: 45–49, 1929) 1930.

[6] A. L. Romanoff and A. J. Romanoff, *Biol. Bul.*, 57: 300–306, 1929.

[7] A. L. Romanoff, *Jour. Exp. Zool.*, 54: 343–348, 1929.

[8] A. L. Romanoff and A. J. Romanoff, *Jour. Exp. Zool.*, 56: 451–457, 1930.

[9] The data from two years of experimental work are ready for publication.

[10] The assembling of this laboratory incubator was made possible in part through the assistance of the Smith Incubator Company Fellowship Fund.

ALEXIS L. ROMANOFF

CORNELL UNIVERSITY

SPECIAL ARTICLES

ON THE LAWS OF KINETIC SYSTEMS

THE general law of growth which populations tend to follow is well known. It is expressed graphically by Verhulst's "logistic curve," rediscovered by Pearl and Reed,[1] and may be stated as follows:

> While periodic renewal maintains its limited resources in matter and energy at one level, a population so multiplies that the proportional increase anticipated in absence of checks fails in the same measure as the attained fraction of the limiting population grows.

This is the master law of populations composed of a single sort of organism, populations in the ordinary sense, *simple* populations. Consider the damping effect of population upon its own growth-rate a measure of pressure, and the law may be stated more briefly. It is set down next in its concise form, with four additional laws derivable from it by inspection.

> *General law of simple populations:* While periodic renewal maintains its limited resources at a constant level, the pressure in a population varies as the attained fraction of its limit.
>
> *Secondary laws:* (1) When in a population the average individual energy is constant, pressure varies inversely as the volume occupied.
>
> (2) In a mixed population each component exerts the same pressure as if it alone occupied the whole volume, and the total equals the sum of the several partial pressures.
>
> (3) If the average energy of their units be the same, equal volumes of two populations under the same pressure contain the same number of individuals.
>
> (4) At constant pressure the volume occupied by a population, and at constant volume the pressure in a population, varies as the average individual energy.

Here it must be stated that in applying the secondary laws of populations, or in testing their applicability to empirical data, one must always measure volume in appropriate units. In working with flies, for example, a pint bottle doubly charged with banana-agar may not be considered an experimental "universe" of twice the volume of a half-pint singly charged. The true two-unit universe is one composed of two half-pint bottles with a single charge each.

In the pint bottle doubly charged, the whole method of yeast culture, for use of the adult *Drosophila* population it largely supports, is changed by altering the relation between surface and volume of the substratum on which the yeast is grown. The result is just such as a revolutionary change in agricultural methods would entail in the growth of a human population. Or, again, the transfer of a fly population from two communicating half-pint bottles normally charged to a pint bottle doubly charged, if all the details of Pearl's culture method were followed throughout, should induce just such a change in the curve of population growth as occurred when Germany and Japan turned from agriculture to industry in the nineteenth century.[2] A change opposite in sign should probably follow the transfer of a similar population to four gill-bottles connected with one another and provided with half the standard charge each.

The situation may be seen more clearly if approached from another direction. Space, from the standpoint of the kinetic theory of gases, does not differ qualitatively from point to point. But from that of populations it has structure virtually imposed upon it; if not by the mode of distribution of sources of matter and energy, then by the distribution of opportunity for the disposition of population wastes. Thus to add unit to unit of volume, when dealing with simple populations, it is necessary to add to one structured system another quite like it; or, in effect, to measure volume in terms of the unit universe, be it what it may, rather than in standard cubic centimeters or inches.

Another point requires passing mention: The pressure in a population varies with the attained fraction of its limit; and the limit is fixed by the ratio between available maximum in some critical factor and individual need. But need and expenditure, intake and outgo, are merely the debit and credit sides of the organism's ledger account with energy. Hence the legitimate substitution of the term "individual energy" for "individual need" in the secondary laws of simple populations to which we now return.

These laws relate to one another four terms—pressure, volume, number and average individual energy. But these are the terms which appear in the gas laws, and the relations said to exist between them are precisely the same in the two cases. We must therefore count the secondary laws of simple populations homologues, not distant analogues,[3] of the gas laws: and, by the same reasoning as we pass from empirical laws to a kinetic theory of gases, we must pass from their own empirical laws to a kinetic theory of simple populations.

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[1] *Proc. Nat. Acad. Sci.*, vi, pp. 275–288, 1920.

[2] Raymond Pearl, "Biology of Population Growth," pp. 19–21, 1925.

It has been suggested earlier[4] that in great natural groups of organisms genera grow according to one law which varies from group to group only as growth according to the logistic curve varies from population to population. This law of generic growth, law of differentiation, or law of evolution, is the master law of second-order populations. It may be expressed by a graph of which the ordinates in order are proportional to the sums, from the second onward, of the homologous terms of an infinite series of infinite descending geometric progressions of equal sum, whose common ratios lie between 0 and 1.0, with normal frequency distribution about the mean.

In this statement the veneer of mathematical phrases overlies sound biological and typically Darwinian construction. Aside from the idea that survival values fluctuate according to the law of chance, nothing is implied beyond the fact that variation, inheritance and natural selection are factors in evolution. But where species beget species by a process of generation in which like tends to produce like, a tendency for types to increase in geometrical progression will appear. And where there is struggle for place, a limit to the number of types which may be produced is indicated.

The joint effect of the two factors, tendency to geometric increase and the damping effect of pressure, imposed on the terms it is by the fixed limit, is to make growth in populations of organisms follow the logistic curve. But where the law of the logistic holds, lesser laws—homologues of the gas laws—hold also; and where these hold we deal with a kinetic system. Species-populations, or second-order populations, are therefore kinetic systems.

If at this point the soundness of the conclusion seems to depend wholly upon the correctness of the premises, the reader should consider these facts: Analysis of the data of taxonomy and distribution shows that species of large genera occupy upon the average large areas, while those of small genera similarly occupy small. This is clear evidence that descendant species inherit ancestral ability, more correctly the bases of ancestral ability. Jaccard's law, that the number of species per genus in a region varies with the ruggedness of the topography, shows as clearly that the number of species which may be produced in any natural group is limited. Finally, the data of paleontology, fragmentary as they are, as far as they go are consistent with the idea that increase in species-populations follows the logistic curve.

Besides the three mentioned still another type of kinetic system is the "excited" or glowing gas. The relative intensities of the lines in its spectrum change with changes in its temperature. The change proceeds regularly. The total number of its atoms active in absorbing (or emitting) a subordinate series of lines increases, passes through a maximum and decreases again, as the temperature is raised..[5] The effects of pressure are as general and regular. With increase all lines shift toward the red, the shift in each series being more marked on the part of lines appearing at high temperature.[6] Intensities, too, according to Miss Payne, should be affected by pressure generally and regularly.[7]

In short, then, a normal and an "excited" gas, a simple and a second-order population seem four distinct types of kinetic system. Because of the activity of their units, be they what they may, and their random action one upon another, certain of the laws of the four are alike in principle. This group of laws, common to kinetic systems as here understood, are the gas laws and their homologues.

But, besides the peculiarities they share, the units of these several systems have their distinctive attributes. One is neither variable nor capable of reproduction; another is capable of variation but incapable of reproduction. Still another is (by definition) capable of reproduction but no variation, and the last both reproduces and varies genetically.

It is to these differences we must ascribe the fact that the master laws of the several systems are different. That of the first is the ideal gas law, $pv = kT$. From it, as from the master law in each system, the lesser laws of the system are deducible in detail.

The master law of the second system is the law of distribution of energy in the line spectrum of an "excited" gas, for this clearly reflects the statistical distribution by state of its variable units, when that depends at once upon energy level maintained in the system and the pressure to which it is subjected. The curves setting forth its variations for a particular gas in different states of excitation will differ only as the curves of distribution of energy in the thermal spectrum differ with temperature, or those for the continuous x-ray spectrum differ with excitation potential, or as the logistic curve differs from population to population of one sort grown under different conditions.

---

[3] A. J. Lotka, "Elements of Physical Biology," pp. 305–306, 1925.

[4] W. H. Longley, SCIENCE, lxxiii, 1904, pp. 700–702, June 26, 1931, and *Anat. Rec.*, 51, pp. 89 and 113, November, 1931.

[5] C. H. Payne, "Stellar Atmospheres," pp. 23 and 101, 1925.

[6] H. D. Babcock, *Astrophys. Jour.*, lxvii, 230–261, 1928.

[7] C. H. Payne, *loc. cit.*, p. 144.

The master law of the simple population has been discussed in full above. That of the second-order population, in addition to the gas laws' horologues. but the law of the logistic curve holds also in this population, in addition to the gas laws' homologues.

In conclusion we summarize the findings in this and preceding brief notes in SCIENCE a possible reader may perhaps, for obvious reasons, best take up in reversed chronological order.

The grouping of organisms in genera and species is justified by the order of nature. Taxonomy is a science, not an art. There is a definite mode of growth of knowledge of species in their genera and their ranges, from which it appears that evolution is a fact and its process Darwinian in principle. The differentiation of genera and species in a great natural group of organisms occurs according to a law affiliated with the gas laws and others, and is as capable as any of mathematical expression. These all are the laws of physical systems readily characterized, and associated naturally under the terms of an amplified kinetic theory.

W. H. LONGLEY
GOUCHER COLLEGE

RATE OF SEA CLIFF RECESSION ON THE PROPERTY OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY AT LA JOLLA, CALIFORNIA

ABOUT two years ago measurements were made of the amount of recession of three cliffs on the property of the Scripps Institution between the years 1918 and 1930, that is, within twelve years. The results of the study were included in the report of the committee on features and changes of the shoreline of the Pacific Coast, Division of Geology and Geography, National Research Council, May 3, 1930, and they were distributed in mimeographed form, but there appears to be doubt as to whether the appearance of the results in the report mentioned constitutes publication. Since much interest has been manifested in the study it seems desirable to remove any doubt regarding publication. A summary of the results is as follows:

The first cliff is 21 feet high and it had receded 20 feet since 1918. The second cliff is 33 feet high and it had receded 15 feet since 1918, and was undercut at the time the measurement was made to a depth of 8 feet. The third cliff is 54 feet high and since 1918 it had receded between 10 and 12 feet. The heights of these cliffs were plotted as abscisses on coordinate paper and the amount of the recession as ordinates. The equation for rates of recession in terms of height was determined by Dr. G. F. McEwen, of the Scripps Institution. It is

$$y = 138\,x^{-.\text{[illegible]}}$$

Dr. McEwen has prepared a table of cliff heights in feet and rates of recession in feet per year according to this formula. It is as follows:

Height = x	Recession rates = y	Observations	
		Height	Recession in 12 yrs.
5	4.100		
10	2.650		
15	2.080		
20	1.720	21	20
25	1.490		
30	1.330	33	15
40	1.100		
50	.960	54	11
75	.740		
100	.620		
150	.470		
200	.400		
250	.340		
300	.300		
400	.250		
500	.220		

The material, composing the cliffs studied, is a non-indurated clay loam, but the lowest bed in the highest cliff is fairly tough, argillaceous, sandy material with considerable calcium carbonate cement. It appears that the rate of erosion of the loam is not faster than that of the basal bed of the cliff.

It scarcely needs to be said that, although measurements such as are given above are of interest, before entirely satisfactory conclusions can be reached there should be a much larger body of data.

T. WAYLAND VAUGHAN
SCRIPPS INSTITUTION OF OCEANOGRAPHY,
LA JOLLA, CALIFORNIA

BOOKS RECEIVED

Carnegie Institution of Washington. Year Book No. 30. Pp. xix + 505. The Institution.

FORTUNE, R. F. *Sorcerers of Dobu*. Pp. xxviii + 318. Illustrated. Dutton. $5.00.

HERSKOVITS, MELVILLE J. *Anthropometry of the American Negro*. Pp. xv + 283. 34 figures. Columbia University Press. $4.00.

HUGHES, ARTHUR L., and LEE A. DUBRIDGE. *Photoelectric Phenomena*. Pp. xii + 531. 169 figures. McGraw-Hill. $5.00.

LABOURET, HENRI. Les Tribus Du Rameau Lobi. Pp. vii + 510. 31 plates. Institut D'Ethnologie, Paris.

SOHON, F. W. *Introductory to Theoretical Seismology: Part II, Seismometry*. Pp. ix + 149. 26 figures. Wiley. $2.75.

SYMONDS, PERCIVAL M. *Diagnosing Personality and Conduct*. Pp. xvi + 602. Century. $4.00.

VERNON, M. D. *The Experimental Study of Reading*. Pp. xv + 190. 14 figures. Cambridge University Press, Macmillan. $3.00.

SCIENCE

Vol. 75 Friday, March 4, 1932 No. 1940

Problems of the Engineer: Dr. Frank B. Jewett 251

On Postulates of Proof in Problems of the Bacterial Life Cycle: Professor Hans Zinsser 256

Scientific Events:
Plan for a Chemical Center in Chicago; The Allegany School of Natural History; Appropriations for Grants in Aid by the National Research Council; The Washington Award; Award of the Popular Science Monthly 258

Scientific Notes and News 261

Discussion:
The Glacial Control Theory Applied to Bermuda: Professor Charles Schuchert. *Cobalt in Plant Ash:* Professor Edna R. Bishop and Margaret Lawrenz. *The Relationship of the Granites to the Rhyolites in Southeastern Missouri:* W. A. Tarr. *The Rôle of Cannibalism in the Spread of Fungous Diseases of Grasshoppers:* Maurice T. James. *The Iron-Deficiency Hypothesis in Pellagra:* Professor Sidney Bliss. *Kreezer and Darge on Auditory Action Currents:* Professor E. G. Wever and C. W. Bray 264

Scientific Apparatus and Laboratory Methods:
The Centrifuge-Microscope for Super-Centrifugal Forces: Professor E. Newton Harvey. *A Simple Method for Separating Certain Insects from Food Products:* J. D. Wildman 267

Special Articles:
Paternal and Maternal Inheritance in Fragaria: G. Leonard Rygg and Dr. George M. Darrow. *Passive Immunity to Infection with a Larval Tapeworm of the Albino Rat:* Dr. Harry M. Miller, Jr., and Margaret L. Gardiner 269

Science News 10

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PROBLEMS OF THE ENGINEER

By Dr. FRANK B. JEWETT
BELL TELEPHONE LABORATORIES

After a great many years of activity in one branch of the engineering profession, and through it having had some considerable contact with practically all the other branches of engineering, it seems to me that we are approaching an era—possibly we are already in that era—when the problems of the engineer, and particularly the problems of the engineering profession, are about to undergo some rather radical changes in their fundamental features. Whether we like it or not, and whether we would change the situation if we could, it seems clear not only that we are living in a highly mechanized age, but also that we and our children and their children are destined to continue to live in an even more highly mechanized environment. Periodically we hear or read statements and wails to the effect that it would be nice if we could return to a simpler mode of living. Any such possibility seems to be quite out of the question, however. The things of science which have been made useful to the people through the work of engineers have not only come to stay but are destined to increase in number. They have come in such large measure already, and they bid fair to come in such greater measure in the years ahead that many of the old controls which were developed through long ages of human activity no longer suffice for a proper ordering of them for the well-being of society.

We have about us everywhere the evidences of attempts to control a new scheme of living through the rules and regulations which grew up in an essentially agricultural and trading age. We are witness to all sorts of legislative action taken in an endeavor to control by statute things which can not be con-

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[1] Address of the retiring vice-president of Section M—Engineering, American Association for the Advancement of Science, New Orleans, Louisiana, December 30, 1931.

trolled except in the light of a complete understanding of their scientific and engineering significance. Under the circumstances in which we find ourselves, it seems to me that if the people of the world are to live happily in the years ahead, and if their affairs are to be ordered in measurably decent fashion, a better general understanding of the things of science and engineering is imperative. Nor can this better understanding be confined to the limited few who make up the group of scientists and engineers. It must be an understanding which in some measure enters into our collective thinking and into our acts as a group of human beings bound together by what we commonly call political ties. If this premise is correct it would appear that the engineer must of necessity play an increasingly important part in the general scheme of things, since he is the only man who in general has that full understanding of the facts of science as applied to the affairs of everyday life which is necessary for a proper operation of the new controls.

As I look back to my own experience, and still farther back through history, particularly the history of these last one hundred years, it seems evident that we of the engineering profession have been in principal measure so largely concerned with and so interested in physical things, in the creating of new structures and of new applications of old and new science, that we have been content to let the social significance of our work rest wholly in the hands of non-scientific or non-technically trained people. It is true that, individually, in practically every activity in which we have engaged, we have had some influence in molding affairs. Nevertheless, acting as a group, we have not taken the same part in the evolution of society in this mechanized age that I think we are to and must take in the years ahead of us. If you grant this premise, then it seems to me obvious that there are two main problems—three main problems possibly—to which some thought must be given.

In the first place there are the problems of education for the young men who are to be our engineering successors. Up to the present time our scheme of engineering education has been essentially one which acquainted young men with the fundamentals of their profession and something of the groundwork of science, on which all engineering is based. It has been concerned in addition with the rules by which science is applied in the profession of engineering—rules which in the last analysis are nothing but the job of mixing fundamental science with dollars in an economic structure. Of course this aspect of engineering education is bound always to be a very large part in any scheme of technical training. There must always be a large number of men who are competent to take the facts of science and the rules of engineering and apply them for practical purposes. Further, no man is likely to achieve to real eminence in the broader aspects of a social service based on engineering unless he is himself competent to do and judge some at least of the things which are the hallmark of good professional engineering.

Beyond this basic requirement, if I am right in my picture of the years ahead, it may well be that in some at least of our engineering schools—possibly in most of them—more emphasis will come to be laid on the social side of the engineering profession. Where this is done the objective will be so to endow the young men who go out from the schools that they will be competent not only to do the kinds of things that you and I have been called upon to do in our active life, but more competent than we to take their places in the whole scheme of evolving society.

Then there are the problems which affect us in our professional association one with another, that is, in our technical societies. In the past our societies have been in large measure places of meeting where technicians could gather together for a general interchange of ideas, for a discussion of technical problems and for the taking of whatever group action seemed advantageous for the advancement of our profession. Possibly in the years ahead our engineering societies, either through modification of their present organizations or in their associations one with another in such things as the American Engineering Council, will find it expedient and necessary to equip themselves in better fashion to play the part which society has a right to demand of us, its experts in this particular field, in bringing to play on the problems which will confront our people the general consensus of understanding which we alone possess in the greatest measure.

Finally, there are the problems of a better education of the great rank and file of the population who have an interest in but no specific concern with the practical applications of science. I surmise that a large part of the things which we are prone to criticize in the acts of our political leaders, our political parties and our various social groups, are not so much due to any malicious desire to warp the situation as they are due to a fundamental ignorance of the factors which are involved. In a word, where these acts seem to play ducks and drakes with the facts of science and engineering they are, I think, in the main, the unintentional result of insufficient understanding.

We who are engaged in any field of science or its application know that the most dangerous thing we can do is to fool ourselves, or permit ourselves to be fooled, with regard to the facts of science or engineering. Old Dame Nature has a very unpleasant way of never fooling herself or allowing her votaries to be fooled with impunity. If we engineers either consciously or unconsciously misuse or misapply facts, we are pretty sure sooner or later to find ourselves in serious difficulties. For the engineer who finds himself in this kind of trouble there is in the main no extenuating alibi. This being so, and if I am right in my suspicion that a large part of the things we now criticize is due to ignorance on the part of the public generally, then, to such an extent as is possible with a great mass of human beings, we owe it to ourselves and to the society of which we are a part, to do what we can to bring about a better general understanding of the possibilities and limitations imposed by nature. In a word, where the facts of science and their application are really the controlling factors in any proposed legislative and administrative undertaking, general knowledge of the inherent possibilities and limitations is highly advantageous.

All of us have had numerous illustrations indicative of the abysmal ignorance of men and women of intelligence about things which seem to us the everyday commonplaces of life. We have equally, I think, all had the experience of seeing how easy it is to educate intelligent individuals or small groups of individuals, if we can only get them to listen to what we have to say. Educating the occasional individual or occasional small groups, as to some particular topic, is, however, quite a different problem from that of educating millions of people. Nevertheless, it seems to me that these millions of people must, in the years ahead, come to have a better understanding of the fundamentals of science and engineering than have their parents and grandparents. Moreover, we scientists and engineers must in some way or other take a real part in bringing about that education. Further, either individually or collectively, we must be prepared to play a real part not alone in our purely technical activities but as citizens of the community and of the nation in which we live.

So much for some of the reasons which lead me to believe that we are on the verge of a different kind of engineering life than we have experienced these last forty or fifty years. Now there are two things which seem to me to indicate a change in the point of view and, through it, in the activities of engineers as regards the more strictly professional side of their work.

One of these is that in many fields of engineering we seem to be reaching the ultimate of possibility in our applications of the things of science. I use the word "seem" advisedly, for frequently when I have thought that we were clearly at or near the end of our rope I have had brought to my attention something which caused me to wonder whether my conclusions were as sound as I thought they were.

Take, for example, the matter of dams. While I am not a civil engineer, I do know a little of civil engineering and am cognizant of the fact that dams to impound water are among the most ancient of man's engineering structures. I presume that the first dams were built untold centuries before there was any recorded history. This being so, one might easily think that in all the long period of human history men would have had experience with every conceivable element entering into the construction of dams, and so would know all there was to be known about them. Yet when one talks with one's civil engineering friends, and when one reads the more or less acrimonious discussion which goes on with regard to the stability of gravity dams, the cause of failure of such things as the St. Francis dam, and the probable stability of the great new Hoover dam, one begins to wonder just how much we really do know about them.

Despite such uncertainties there are nevertheless some fields where there seem to be fairly clear indications that our prsent applications have reached close to the limit of the possibilities permitted to us by the fundamental facts of science.

As an example, I can cite one illustration in my own field of engineering where we seem close to the limit. Not being clairvoyant, I am even here, however, uncertain as to what future science may have in store for us. What I do know is that in the present state of scientific knowledge we in the communication field have in some directions just about reached the point where we can not hope to go farther along lines which have been tremendously fruitful in the past. As an illustration of what I have in mind, let me cite a simple case involving the transmission to great distances, of electrical impulses. Fifteen years or so ago very great advances were made in extending the range of electrical communication through the development and introduction of distortionless amplifying devices. You are all acquainted with one form of such devices in the vacuum tubes of your household radio sets. As employed in the extension of electrical communication these devices are made to control relatively large amounts of fresh energy supplied to the transmission channel at points distant from the sending station, in such a way that the minute control impulses which reach them are magnified many fold without distortion of form. In a word, they are employed in such manner that they appear to a still more distant point as the relatively near-by primary origin of the impulses.

These devices of practical utility, which grew out of fundamental research in physics, opened the door to what appeared to be an almost illimitable amplification of very small amounts of energy without distortion. Initially it appeared as though one might go on practically ad infinitum in the multiplication of energy under the control of very weak impulses and so provide for spanning almost any terrestrial distance which might be involved in electrical communication. For a considerable number of years after their initial introduction this assumption seemed to be quite within the bounds of practical possibility. It still appears to be within those bounds wherever it is reasonably possible to provide intermediate amplifying equipment to the communication channel at suitable intervals.

Recently, however, in our attempts to span very great distances where we were deprived of the possibility of providing these revivifying agencies, as we can on land lines, we have come face to face with what appears to be the stone wall of a fundamental obstacle inherent in the nature of matter. Specifically, we have encountered this obstacle in our attempts to bridge great ocean distances, such as the Atlantic, with a telephone table. Here, because we are deprived of the possibility of installing intermediate amplifiers, we must, if the problem is to be solved, at all, depend, at the distant end of our circuit, on the minute remnant which remains of the energy imparted to that circuit at the sending end. This might not be a serious obstacle if we had to deal only with the fact that this remnant of energy was minute. All that might be required in such a case would be the introduction of a train of amplifying devices each adding its increment to the elevation of the energy level.

What we do encounter is, however, something quite different. We find the remnant of energy with which we have to deal is so minute that it is approaching the level of the electrical energies involved in the noises produced by thermal agitation within the material of the conductor itself. A short step further in this diminution, such as might easily be produced by an extension of distance, will bring us to the point where no amount of amplification can be of service, since any amplification will elevate equally both the desired impulses and their masking background of noise, and we know of no way of separating the two. Unless and until, therefore, some one finds either a metal which has a lower background of inherent noise, or a way by which that background of noise, which covers the entire spectrum, can be gotten rid of, there is a definite limit to what we can do.

Other examples might, I think, be cited to indicate that in certain other branches of engineering there are in the present state of our knowledge definite limits to what we can do in an engineering way. Where such fundamental obstacles are found to exist it is obvious that the past course of engineering development, on its more technical side, must be altered. In a word, we will have in such fields reached the frontiers and must consequently direct our energies to developments within those frontiers. Put another way, it means that in those particular sectors the engineering of the future must be directed to the problem of filling in gaps which now remain, in bettering the structures which we have already erected inside the frontier, in cheapening these structures, or in the thousand and one ways with which we settle up an already discovered country.

In other directions and in other branches of engineering it is quite obvious that we have not yet reached the point where such limits have begun to operate. In these fields progress can still be made along the old lines, although even in such areas I imagine that, relatively, we shall see much more attention given to the filling-in processes as we go along than may have been the case in times past.

There is another direction in which it seems to me that the engineering profession of the years ahead is likely to have a somewhat different point of view and a somewhat different method of approach from that which we have known in the past. Fundamental science has been bringing to us as raw material for our profession, these last three or four decades, a perfectly stupendous amount of new knowledge. New facts thoroughly proven in the research laboratory have been placed at our disposal to be applied as were the older facts which were their predecessors. In the main these new facts have had to do primarily with the ultimate structure of matter. They have placed and are placing in our hands smaller building bricks than we have had to deal with, and very much smaller building bricks than our engineering predecessors of a few decades ago had to deal with. All of us know that finer and more substantial structures can be made with finer ultimate elements than can be fashioned out of cruder things. To the extent therefore that this is so, it means both that our engineering structures of the future and the engineering attack which produces them must be concerned more with intimate details than has been the case in the past.

Further, in many branches of engineering, this added knowledge which the physicists and chemists are placing at our disposal is indicating quite clearly the basic causes of some of those failures which in the past we have guarded against by the rather crude processes of enlarged dimensions which we have come to designate as factors of safety. To me these so-called factors of safety should in fact, to a large extent, more properly be designated as factors of ignorance. Factors of safety will still be involved to insure against the unknown in the matter of maximum stresses, but they should in large measure be eliminated insofar as the inherent properties of the structural material itself is concerned.

Obviously, the more we can know with certainty about the things with which we deal, the farther we can go in refining our engineering in the design of our structures. This fact alone seems to be certain to have a very considerable influence on the type of education which we shall afford the young men who are to be the engineers of the future. Those among these young men who have in them the ability to reach the top of their profession, in whatever field of engineering, must be provided with a better knowledge of physics and chemistry and the underlying principles which guide their practical application than you and I were given when we were going through the rudiments of our technical education.

As an illustration of the necessity for this more intimate knowledge of basic things, it is easy to show in some branches of engineering that such knowledge is absolutely essential to progress and safety. For example, we have in recent years learned that in certain alloys and aggregates very minute admixtures of certain things produce effects which are out of all proportion to the amount of the extraneous material. Frequently these effects have been deleterious and the minute admixtures have been referred to as poisons. In other cases the effects have been beneficial.

Again, turning to the field with which I am best acquainted, I can cite you an example of what I have in mind.

Some years ago, in our quest for a magnetic material which would be more magnetic than the best irons and steels which were then available, and which, if produced, would open up wide avenues of progress, we evolved an alloy of nickel and iron. As I remember it, it was an alloy containing about 78 per cent. nickel and 22 per cent. iron. This alloy, when properly fabricated and properly heat-treated, had very remarkable magnetic properties. For the magnetizing forces with which we have to deal in communication circuits it was found to be many times more magnetic than the best irons and steels previously available and to have other desirable properties. It was consequently a very valuable addition to our store of structural materials. At the same time we learned, however, that very small admixtures of certain ingredients into the alloy had tremendous deleterious or poisoning effects on the magnetic properties of the alloy.

This discovery was a striking illustration not only of the effect of small things in upsetting the calculations which might otherwise have been made, but also of the dangers which one runs in proceeding too boldly to use some new discovery without the most complete and exhaustive investigation of the things which may result from slight deviations from absolute perfection. If I remember correctly, some rather disastrous consequences have followed attempts to use some of the newer steels or some of the newer forms of heat treatment of steel in mechanical structures. In all such cases which come to mind, the difficulty was either lack of complete understanding or failure to enforce rigorously the known controls in the factory.

Thus in many directions the engineer of the future, in my judgment, must of necessity deal with a much more certain and more intimate knowledge of the materials with which he works than we have been wont to deal with in the past. As a result of this more intimate knowledge his structures will be more refined and his factors of safety in many directions are bound to be less because the old elements of uncertainty will have in large measure disappeared. All in all he will be working on a sounder base of knowledge than has heretofore been possible. To the extent that this is possible, it must inevitably have a very considerable influence on the type of education given in our technical schools, at least to the men who have the inherent capacity to develop into the leaders of the engineering profession.

I would add just one word more about the changes which it seems to me are likely to come about in the relation of our successors to our profession. Whatever changes there may be in the intellectual or social phases of engineering, one can not escape a realization of the tremendous interest which resides in the purely physical. It is a type of interest which does not exist in any purely intellectual type of achievement. As one advances in years and experience the normal tendency of the engineer is to become more and more involved in phases of engineering which are essentially intellectual, and to a large extent lacking in personal contact with the purely physical. No matter how much satisfaction one may derive from the successful completion of a task of this kind, it is devoid of much of the thrill that accompanies the creation of a physical thing with one's own hands or through one's own efforts. I know this from my own experience, and while I derive a large amount of pleasure from the solution of the problems with which I now deal, they do not linger vividly in my memory as do the problems of my earlier years. As a matter of fact, I doubt if I derive as much personal enjoyment from the things of my business life as I do from the simple little structures which I make in my own shop merely as a matter of personal relaxation.

There is something stimulating in the creation of things which exist physically, which you can look at or feel, which does not exist in any purely intellectual achievement. This being so, I would not for a moment desire that the training of engineers for the future should so over-emphasize the purely intellectual side of our profession as to blot out the training which will enable men to produce things physically.

We must always have in mind that our engineers, in the last analysis, must be the creators of physical things if they are to be real producers, have a real understanding of their profession, and be able to play the enlarged part which I foresee to be the province of our successors.

As a telephone engineer I get a tremendous kick, whenever I go across the continent, merely in looking out of the car window and seeing such a simple thing as the pole line which carries the transcontinental circuits. Why? Because I realize that some of the best and happiest years of my life were spent in the creation of that very physical thing. At the present time I deal with similar problems almost wholly in an abstract way. I decide what sort of things should be done and I pass judgment on the work of others, but in the main I have no part in the construction of the things themselves. My life is given up almost entirely to paper-shuffling and various forms of intellectual gymnastics, which leave in me relatively little satisfaction.

ON POSTULATES OF PROOF IN PROBLEMS OF THE BACTERIAL LIFE CYCLE

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INTO many of the etiological questions of modern bacteriology there have been introduced problems of far-reaching biological consequences, which must be approached with the grim logic of the bacteriological forefathers unless we are to flounder in a bewildering confusion. These are the matters of the filterable stages of true bacteria and the suggested cyclic relationship between bacteria and the ultramicroscopic viruses. These two questions have often been confused with each other and there is a growing school of investigators from whose work it is often unclear whether they advocate one of these theories only or whether, in claiming the truth of one, they mean to imply that of the other as well. In regard to these developments, bacteriology is in much the same confusion with which it was threatened in the early etiological era, when countless false leads were laboriously followed out by investigators who attached etiological conclusions to the mere isolation of any organism from an animal or man suffering from a specific disease. And the formulation of his postulates by Koch was the warning of an uncompromising disciple of the truth against the dangers of allowing faulty reasoning to leap across experimental chasms. It is time for us to set up, in consultation, similar postulates in regard to the problems alluded to, if we are to avoid the obstructions to permanent progress which loose reasoning always produces. For there is no room for two schools of theory in any of these matters. Either a proposition is demonstrable by experiment, and confirmable, or it is not. And it can only delay the successful pursuit of the truth to claim, as established fact, conditions which have not been so established by observation. No one would be more delighted than the writer of these notes if most of the claims that have recently tended to establish a traceable cyclic relationship between invisible and visible forms of bacterial life could be substantiated. Such an achievement would enormously increase the capacity of bacteriologic methods to clarify important biological and medical problems. But we gain nothing in this direction unless we set down clearly the criteria of proof which alone can justify us in incorporating these new conceptions into the premises of our science. Regarding such criteria opinions may differ. It is with the purpose of clarifying this issue that these notes are written.

Let us consider first the question of the existence of filterable forms of true bacteria. The impulse for the present activity in this field was the great progress made in the knowledge of bacterial dissociation. And, in regard to this, it is gratifying to realize that the horizon of bacteriology and immunology has been infinitely enlarged by the studies of the so-called "mutations" in which cultural and colony studies and their immunological and chemical correlations constitute a series of discoveries achieved by the most rigid observance of that type of self-criticism in experiment which, it seems to us, is often lacking in the fields of inquiry which are the subject of this discussion. That all methods of bacterial filtration are complicated by a host of experimental irregularities is well known. And that there is no satisfactory method of appraising any of the ordinary laboratory filters except by actual test is acknowledged by every one who has worked with these methods to any extent. In our own work, we have found that neither the measurement of the amount of freshly distilled water which will pass through a filter, under a stated negative pressure, in a given time, nor the measurement of the pressure which will push air through the filter under water, possess any reliable relationship to the permeability of the filter for bacteria. Also, Ward and Tang in our laboratory showed, some years ago, that the passage of a virus through a filter depended as much upon the suspension fluid as it did on other factors and that the agents of vaccinia and of herpes would pass through a filter with far greater ease when suspended in certain types of broth than when taken up in any of the various isotonic salt solutions, irrespective of pH. Grinnell, then, testing all our Berkfeld and Mandler filters with *B. prodigiosus*, showed that all the "V" candles and most of the "N" ones would let these organisms through under relatively low pressure (10 cm Hg) provided the bacteria were taken from old cultures and were suspended, for filtration, in a hormone broth at about pH 7.8. Moreover, to be sure of the "tightness" of filters so tested, we found, in connection with our early typhus work, that control cultures of filtrates could not be regarded as sterile until they had been incubated for at least two weeks, since many of our controls showed the first prodigiosus growth as late as twelve and thirteen days after filtrate inoculation. From these facts alone it is apparent that the mere passage of bacteria through a filter—even a Berkfeld "N"—is not proof of a filterable form.

It is, of course, quite likely that bacteria, which multiply by fission, may well degenerate into granular fragments far smaller than the characteristic species-forms. It is not only conceivable but even likely that such fragments, containing chromatic materials, may be viable and grow out eventually to the adult stages.[1] But this does not constitute a filterable phase of a cycle. It is biologically far less significant and modifies in no respect our fundamental conception of bacteria.

In order to truly demonstrate the principle of a cycle between filterable and non-filterable—or, more exactly, large and minute forms of a morphological cycle, we would set up the following postulates:

(1) It must be possible to filter a suspension of a well-defined pure culture of bacteria through a filter which holds back the characteristic forms; and these *original forms should not appear in the filtrate or in* cultures made with adequate amounts of the filtrate on suitable media after incubation of at least two or three weeks.

(2) There must be evidence of growth of some kind in cultures made of this filtrate, but without evidence of the presence of the original normal forms.

(3) The culture of the filterable or minute form must be carried in a series of several generations.

(4) It must be possible to recover the normal forms *from such successive* "filterable attributes.

Such requirements have not, as far as we know, been fulfilled by Mellon, by Rosenow or by Kendall, who are among the chief protagonists of the existence of filterable stages. They have been reported, we believe, only by Hadley, who gives details in regard to his Shiga bacillus filtration, but this work has not yet been sufficiently confirmed. Hadley, incidentally, is also quite definite in rejecting any implication that he suggests identification of his "filterable bacterial forms" with the so-called "ultramicroscopic virus" groups.

When we come to the suggestion that infectious agents, such as those of herpes, poliomyelitis, etc., are merely filterable or ultramicroscopic forms of well-known bacteria, we are confronted with a problem that threatens still greater dangers of possible confusion. It is of course, an obvious thought that has come to every one who has been frustrated by the difficulties which confront those who are laboring for a break-through in this field of investigation. It is not originality, but rather boldness—we might say intellectual recklessness—which seems to us to characterize the claims for such a cycle on anything less than convincing evidence. It is a fascinating way out of our difficulties, and the voice of caution is too apt, just now, to be suspected of unimaginatively academic hostility to new ideas, which is justly regarded as the opposite pole of obstruction to progress.

The claim of such cycles has been made, either in statement or implication, by a number of workers who need not be named, both in connection with herpes encephalitis, poliomyelitis and fox encephalitis. And the point of view has become widely disseminated among clinicians. To those who work with the ultramicroscopic viruses, however, a number of attributes of these agents are obvious which caution them to demand complete proof before they permit themselves to regard them merely as stages in a cyclic metamorphosis of bacteria. These properties, apart from the usually ultramicroscopic magnitudes which determine filterability, are the following:

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[1] Every one who has worked with the cholera spirillum and many other similar organisms knows that old cultures show almost no characteristic individual forms. Smears from such cultures are swollen, granular and unrecognizable as true spirilla. Yet, on transfer, the typical morphology reappears. We were, at one time, tempted to interpret, as possible evidence of a new type of bacterial life, the fact that our filtrates of typhus material, controlled with prodigiosus, showed no growth in cultures for as long as twelve days, after which period the original forms appeared in the tubes. This is, however, much less sensationally explicable on the basis of latency of a few organisms under conditions of the unusual environment furnished by filtrates containing many fresh tissue constituents.

(1) Except for the as yet insufficiently confirmed experiments of Eagles with tissue extracts, no filterable virus has been cultivated except in the presence of living cells in tissue culture.[2]

(2) Many of the viruses have been serially cultivated in tissue culture without reversion to the bacterial form.

(3) They produce diseases which are specific and unlike those produced by any known bacteria, even those produced by the bacteria supposed to have been developed out of the viruses themselves.

(4) The pathological histology characteristic of the virus diseases is entirely unlike that of any of the true bacterial lesions but, on the other hand, there is much similarity between the histological strategies aroused in animal tissues against the various filterable agents.

(5) In the lesions of most (almost all) filterable virus diseases characteristic "inclusion bodies" are present.

(6) There are many indications which render it likely that the theater of conflict in the virus diseases is an intracellular one.

(7) Active immunization in the virus disease is (with two exceptions which are not yet clearly understood) impossible unless living virus is used.

(8) The protective bodies differ from bacterial antibodies both in their limited concentration, even with hyperimmunization, and in the difficulty and uncertainty of demonstrating any *in vitro* reactions.

(9) There is a striking concentration of virus in specific tissues like nervous system and skin.

(10) There is a likelihood of persistence of the viruses in the animal body as long as immunity persists.

In addition to these points there are many minor facts, such as resistance to glycerine, to chemical agents and to heat; relationship to oxidation and reduction and to salt concentrations such as those recently demonstrated by Clark, all of which demand more study—but which, taken together, should caution us against any rash assumptions of relationship to bacteria, however attractive and startling such speculation may appear to be.

We do not want to be understood as throwing out of court the theory of cyclic relationship between bacteria and the virus group. Indeed, the possibility of such a relationship is perhaps the most important problem confronting the bacteriologist to-day. However, there is little sense and no utility in piling up our literature with repeated assertions of the existence of such a condition, unless definite postulates of proof can be fulfilled; and such postulates we would set down as follows:

Starting with a virus capable of producing a characteristic disease with all the clinical, pathological and immunological criteria necessary for its recognition, the investigator must:

(1) Repeatedly cultivate a bacterium of a single well-defined species.

(2) He must carry this bacterium through a number of culture generations. (If he can produce the disease, in the animal susceptible to the original virus and in a characteristic way, with these cultures, all the better. But this need not be required since virulence may change with form. However, we would attach no importance to such experiments as those of Rosenow with poliomyelitis, in which the bacterium produced a disease in rabbits and ginea-pigs—species entirely resistant to the original virus.)

(3) After a number of bacterial culture generations, it must be possible to get back the virus itself—apart from the bacteria—either by culture or by animal inoculation; the culture generations must be sufficient in number to insure complete removal of the original virus by adequate dilution; and such recaptured virus must possess all the original characteristics as to filterability, specific pathogenicity, etc., of the original material.

Such demands have not, to our knowledge, been fulfilled by any of the investigators who have been protagonists of the cyclic idea. Until such postulates or similar ones—adjusted to new knowledge—are required, however, we will get no farther, and this phase of bacteriology will remain sterile. We might add to all this the modest requirement that the experiments reported in such cases should be repeatable by other qualified investigators.

We sincerely hope that our point of view will be vigorously criticized by those who hold these cyclic metamorphoses to be demonstrable facts. The questions involved are of such fundamental importance that they call for the cooperative efforts of serious bacteriologists to remove them from the realm of speculative reasoning and place them upon a basis of experimental proof comparable to that which has been demanded for every other great bacteriological discovery.

SCIENTIFIC EVENTS

PLAN FOR A CHEMICAL CENTER IN CHICAGO

ON January 30, 1932, representatives of the Chicago Section of the American Chemical Society and of the Chicago Chemists Club signed agreements by which both groups will in the future hold their meetings in the Midland Club. In addition, the Chicago Chemists Club signed a lease for quarters considerably larger than they have previously occupied in the Midland Building, 176 West Adams Street, in which the Midland Club is located. The signing of these agreements marks the termination of negotiations which have been going on for several years to secure enlarged facilities for chemical activities in Chicago. The rapidly growing attendance at meetings of the Chicago Section, which reached six hundred at a special petroleum meeting in January, was making imperative a change in meeting place. The new agreements run for five years and are renewable at the end of that time. In addition to providing accommodations for all meetings of the two organizations, the plan involves the cooperation of the chemical groups in securing tenants from the chemical industry. If this plan is successful and the building secures a considerable number of tenants who are connected with the chemical activities, the name of the building will be changed to indicate its position as a center of chemistry in Chicago.

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[2] We believe that we are correct in assuming that neither the cultivation of the so-called "globoid bodies" in poliomyelitis—nor the cultivation of the agent of mosaic disease are regarded as accomplished facts any longer—even by their original proponents.

The Midland Building is said to be one of the newest and finest of the large club buildings in Chicago and is situated in the heart of the business district. It is fully adequate to accommodate the chemical organizations of Chicago. Negotiations were carried out under the leadership of a building committee headed by Dr. Paul Van Cleef. The chairman of the Chicago Section is Dr. Bernard E. Schaar, and the president of the Chicago Chemists Club is Dr. Ernest H. Volwiler.

THE ALLEGANY SCHOOL OF NATURAL HISTORY

THE sixth season of the Allegany School of Natural History in Allegany State Park opens on July 5 and closes on August 24. This "Summer School in the Forest" is conducted by the Buffalo Society of Natural Sciences in cooperation with the New York State Museum and is affiliated with the University of Buffalo from which its students receive college credit. Registration should be made with Mr. Harold T. Clement, Curator of Education at the Buffalo Museum of Science, or with Dr. R. E. Coker, director of the Allegany School of Natural History, Box 950, Chapel Hill, North Carolina.

Courses will be given in field zoology by Robert E. Coker (Johns Hopkins), professor of zoology, University of North Carolina; in field geology by Mr. Frederick T. Thwaites, lecturer in geology at the University of Wisconsin; in field botany by Mr. Robert B. Gordon, Ph.D. (Ohio State), instructor in botany at the Ohio State University; in the natural history of birds by Aretas A. Saunders, Ph.B. (Yale), teacher of biology, Central High School, Bridgeport, Connecticut, and in nature study by Mr. William P. Alexander, B.Sc. (Cornell), field naturalist and assistant curator of education at the Buffalo Museum of Science.

The Allegany School of Natural History is nine miles from Quaker Bridge, New York, and well above it, being located on a hillside bordering Quaker Run in its upper part at an altitude of about 1,900 feet. It is a feature of the setting of the School in Allegany State Park that within an area of some 65,000 acres under the care of the state much of the wild life is protected, and so one may occasionally see bear and deer, besides observing daily the abundant smaller mammals, chipmunks, field mice and, less frequently, jumping mice, shrews, weasels, mink and others.

Teachers in public schools and colleges, particularly those who have had little opportunity for field studies, university and college students, scout and camp leaders of various kinds, young and amateur naturalists, and those interested in the nature work of museums, public forests and parks, are invited to attend the Allegany School.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT its meeting in February the National Research Council's Committee on Grants-in-Aid made twenty-four grants for the support of research as follows:

Carl E. Howe, associate professor of physics, Oberlin College, for the measurement of wave-lengths of x-rays; Jakob Kunz, professor of theoretical physics, and J. T. Tykociner, research professor of electrical engineering, University of Illinois, for studies of the photoelectric effects of alkali vapor and films and a velocity selector for molecular rays.

W. C. Austin, professor of physiological chemistry, Loyola University School of Medicine, Chicago, for investigations on the transformation of aribose to ribose; Walter L. Badger, professor of chemical engineering, University of Michigan, for investigations on the effect of viscosity on the heat transfer coefficients between metals and boiling liquids; Harold Hibbert, professor of industrial and cellulose chemistry, McGill University, Montreal, for research on plant synthesis and immunology; I. M. Kolthoff, professor of analytical chemistry, University of Minnesota, for investigations on the internal structural changes taking place in a freshly prepared crystalline precipitate on standing; Charles P. Smyth, associate professor of chemistry, Princeton University, for research on the dielectric constants of gases.

Ernst Cloos, department of geology, the Johns Hopkins University, for a survey of the Sierra Nevada batholith; Robert S. Platt, associate professor of geography, University of Chicago, for part of the expense of a study of types of rural land occupancy in South America; H. B. Stenzel, assistant professor of geology, Agricultural and Mechanical College of Texas, for field work on the paleontology and stratigraphy of the lower Claiborne formations.

Alfred Chanutin, professor of biochemistry, University of Virginia, for research on the effect of diet in the partially nephrectomized rat; David M. Greenberg, associate professor of biochemistry, University of California, for research on the biochemistry of magnesium; H. Keffer Hartline, fellow in medical physics, Johnson Foundation, University of Pennsylvania, for a study of visual phenomena as indicated in the impulses in single optic nerve fibers; Carl C. Speidel, professor of anatomy, University of Virginia, for investigations on the fundamental activities of nerves in the living animal.

E. A. Andrews, professor emeritus of zoology, the Johns Hopkins University, for field observations on the variation of snails (*Neritina*) in salt-water ponds in Jamaica; Walter F. Loehwing, professor of botany, State University of Iowa, for a study of the effects of inorganic nutrients on the vegetative and reproductive cycle of plants; William Patten, professor emeritus of zoology, Dartmouth College, for field expenses in collecting material for research on the origin of vertebrates; George Harrison Shull, professor of botany and genetics, Princeton University, for part of the expense of investigations on the genetics of the evening primrose.

Edward F. Castetter, professor of biology, University of New Mexico, for a study of the ethno-biology of the Indians of the southwestern United States; Walter B. Jones, director, Alabama Museum of Natural History, for investigations on the Moundville culture of Alabama; Arthur Randolph Kelly, assistant professor of anthropology, University of Illinois, for a study of the physical anthropology of the Bronze Age people of Greece.

Harold C. Bingham, Sanbornton, New Hampshire, for a comparative study of the psychobiology of gorillas and other anthropoid apes; G. LaVerne Freeman, instructor and research associate in psychology, Northwestern University, for use in a study of diurnal rhythm, including both sleep and waking activity; Donald McLean Purdy, associate professor of psychology, University of Kansas, for the study of an unusual case of defective vision.

GEORGE K. BURGESS,
Chairman

THE WASHINGTON AWARD

THE Washington Award for 1932, "in recognition of devoted, unselfish, and preeminent service in advancing human progress," was presented to Dr. William David Coolidge, associate director of research in the laboratory of the General Electric Company at Schenectady, following a dinner and reception on February 24 at the Hotel Sherman, Chicago. Dr. Coolidge is the eleventh to be so honored by the Washington Award Commission, the first presentation being to President Hoover, in 1919. Dr. Harry Woodburn Chase, president of the University of Illinois, delivered the principal address of the evening, evaluating the importance of research in the present social order.

Among the best-known contributions of Dr. Coolidge are ductile tungsten for lamp filaments, wrought tungsten for contacts and x-ray targets, the hot cathode x-ray tube, various types of x-ray generating equipment, the "C" tube for submarine detection and signalling, and the cathode ray tube.

His achievement of drawn tungsten filaments made the incandescent lamp cheap and reliable, and his improvements in the x-ray tube augmented and made less dangerous to operate that modern laboratory instrument. The beam of Dr. Coolidge's cathode-ray tube, having the power of a ton of radium, has unknown possibilities in the realm of science and medicine. An exhibit of the achievements for which the award was given to Dr. Coolidge was on display at the hotel.

Dr. Coolidge graduated from the Massachusetts Institute of Technology in 1896, afterwards receiving his Ph.D. from the University of Leipzig. Returning to the United States, he joined the teaching staff of the institute, serving as assistant in physics, instructor in physical chemistry, and as assistant professor of physico-chemical research. In 1905 he became a member of the staff of the General Electric Research Laboratory, under Dr. Willis R. Whitney, and in 1908 was made assistant director of that organization, a position he occupied until 1928, when he was made associate director.

The Washington Award, presented to Dr. Coolidge, was founded sixteen years ago by John Watson Alvord, and it is administered by the Western Society of Engineers. Presentation was made by Mr. Frank D. Chase, president of the society.

AWARD OF THE POPULAR SCIENCE MONTHLY

DR. IRVING LANGMUIR, associate director of the research laboratory of the General Electric Company, at Schenectady, N. Y., has received the *Popular Science Monthly* annual award of $10,000 for notable scientific achievement. The award, together with a gold medal commemorating it, was presented to Dr. Langmuir on February 29 at the Engineers Club in New York City.

This award was established two years ago for the double purpose of honoring Americans who have done notable scientific work and of stimulating the public mind to a greater appreciation of the values of scientific investigation. The first winners were Dr. George H. Whipple, of the University of Rochester, and Dr. George R. Minot, of Harvard University, who received the award jointly last year for their discovery and development of a cure for pernicious anemia.

The committee of award consisted of twenty-two leading men of science, and nearly 1,800 organizations were requested to present nominations.

Dr. Langmuir is known for his contributions to the knowledge of atomic structure; the theory of the single molecular layer; the heat of atomic hydrogen and its application to electric arc welding; the effects of gases on electrically heated filaments as applied to gas-filled tungsten lamps, and the laws of electron emission as applied to radio and other vacuum tubes.

Dr. Langmuir was graduated from the School of Mines of Columbia University in 1903. He continued his studies at the University of Göttingen, where he received the doctorate of philosophy. Returning to this country, he served the Stevens Institute of Technology, Hoboken, New Jersey, as instructor of chemistry from 1906 to 1909. Since then, he has been connected with the General Electric Research Laboratories.

SCIENTIFIC NOTES AND NEWS

DR. T. W. STANTON, geologist in charge of paleontology and stratigraphy in the U. S. Geological Survey, has been appointed chief geologist, succeeding Dr. W. C. Mendenhall, who has become director of the survey. Dr. John B. Reeside, geologist, has been placed in charge of paleontology and stratigraphy.

DR. GEORGE E. COGHILL, professor of comparative anatomy at the Wistar Institute, Philadelphia, has been nominated for president of the American Association of Anatomists and will be elected at the meeting to be held in New York on March 25 and 26.

THE Chancellor's Medal, the award of the University of Buffalo for public service, was conferred at the midwinter commencement on February 22 on Dr. Frank A. Hartman, professor of physiology, one of the discoverers of the cortin treatment for Addison's disease.

THE Langley Memorial Prize, which is usually awarded every three years for the best paper submitted by officers of the West African Medical Service, has been awarded by the London School of Hygiene and Tropical Medicine in equal shares for Dr. E. C. Smith's paper entitled "A Dermatological Atlas of Nigeria" and Dr. Hope Gill's paper on "Diagnostic Methods in Human Trypanosomiasis."

DR. DAVIDSON BLACK, professor of anatomy at Peking Union Medical College, has been elected a corresponding member of the Field Museum of Natural History.

A DINNER in honor of the seventy-fifth birthday of Mr. Otto P. Amend, past president of The Chemists' Club, New York, was held at the club on February 3.

DR. JULIUS WAGNER-JAUREGG, who retired three years ago as professor in the Medical School of the University of Vienna and as director of the Psychiatric Neurological Clinic, will celebrate his seventy-fifth birthday on March 8.

PROFESSOR LUDOLF VON KREHL, professor of internal medicine at the University of Heidelberg, known for his work on pathological physiology, celebrated his seventieth birthday on December 26.

PROFESSOR ANSON MARSTON, dean of engineering at the Iowa State College, and Dr. Charles F. Curtiss, dean of agriculture and director of the Agricultural Experiment Station, will retire at the close of the present college year, having reached the age of retirement established by the Iowa State Board of Education.

DR. ROSCOE RAYMOND HYDE has been promoted to be professor of immunology at the School of Hygiene and Public Health of the Johns Hopkins University to succeed the late Dr. Carroll G. Bull.

DR. M. X. SULLIVAN, until recently biochemist of the U. S. Public Health Service, has become director of the Chemo-Medical Research Institute of Georgetown University.

MR. JOHN C. PHILLIPS has been appointed to the staff of the Peabody Museum, Cambridge, filling the vacancy caused by the death of Augustus Hemenway. Messrs. George W. Harley and Philip A. Means have been appointed associates in anthropology.

DR. CLARENCE BEAMAN SMITH, chief of the Office of Cooperative Extension Work of the U. S. Department of Agriculture, who has been associated with the department's extension work since its inception, has been appointed assistant director. Under this arrangement Dr. Smith will, in addition to continuing as chief of the Office of Cooperative Extension Work, assist Dr. C. W. Warburton, director of extension work.

DR. VICTOR C. JACOBSEN, professor of pathology, Albany Medical College, has been awarded a grant of $1,000, by the Committee on Scientific Research of the American Medical Association, to aid in a study of transplantable mouse melanoma, particularly in elucidating the neurogenic theory of melanoma origin.

DR. EDWARD ORTON, JR., from 1894 to 1916 director of the department of ceramic engineering at the Ohio State University and from 1902 to 1915 dean of the College of Engineering, later engaged in manufacturing, died on February 10, at the age of sixty-eight years. Dr. Orton was state geologist of Ohio from 1899 to 1906 and was the founder of the American Ceramic Society.

DR. BENNET M. ALLEN, professor of zoology at the

University of California at Los Angeles, sailed for Naples on February 25. He plans to make a study of the research work being carried on in European laboratories.

PROFESSOR RALPH W. HUFFERD, of the chemistry department of DePauw University, is spending his sabbatical year in Europe. With the exception of six weeks spent in the study of microchemical analysis with Professor Hans Leib, at Graz, Austria, he is devoting the year to a study of the teaching of chemistry in the universities and high schools of Germany, Austria, France and England.

AT the Bureau of Economic Geology, Texas, Mr. W. S. Adkins recently returned from several months spent in Europe as the holder of a Guggenheim fellowship; Mr. F. B. Plummer is on leave of absence in order to give courses in petroleum production engineering at the University of Texas, and Mr. C. L. Baker is giving lectures at Northwestern University.

PROFESSOR GEORG TISCHLER, director of the Botanical Institute at Kiel, delivered some 30 lectures on karyology of plants at the Johns Hopkins University while in residence as the James Speyer visiting professor from November 1 to January 30. He gave during February invitation lectures at several midwest universities and at the University of California. During March he will visit the Desert Laboratory at Tucson, New Orleans and the east coast of Florida for botanical collecting. He will sail for Europe on March 30.

DR. CLARENCE COOK LITTLE, director of the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Maine, formerly president of the University of Michigan, will be the speaker at the commencement exercises of the University of New Hampshire.

A SERIES of eight lectures on "The Problem of Human Wholeness" is being given at the University of California by Dr. William E. Ritter, professor emeritus of zoology.

THE Gehrmann Lectures at the University of Illinois College of Medicine will be given by Dr. C. Macfie Campbell, medical director of the Boston Psychopathic Hospital, and professor of psychiatry in the Harvard Medical School, on March 15, 16 and 17. The topics of Dr. Campbell's lectures are "Schizophrenic Disorders," "Preoccupational and Environmental Problems of the Patient" and "Personal and Environmental Problems, and Resources Available for Treatment."

TRUSTEES of the Ropes Memorial, Salem, Massachusetts, announce the twentieth lecture course of six lectures to be given from March 9 to April 13, on "The Geographic Isolation and the Evolution of Plants," by Professor M. L. Fernald, of Harvard University.

MR. FRED M. HARPHAM, vice-president of the Goodyear Tire and Rubber Company, gave the third Aldred Lecture of the year at the Massachusetts Institute of Technology on February 26. He spoke on "Zeppelin Airships—their Performance and Possibilities." The lecture was followed by motion pictures showing the construction of the dock and *U. S. S. Akron.*

DR. CHRISTIAN A. RUCKMICK, professor of psychology at the University of Iowa, has completed a state-wide lecture tour under the auspices of the Graduate College. Each year a lecturer is chosen on the grounds of his "distinction as an investigator" to present materials of his research to colleges and universities of the state. The subject of Dr. Ruckmick's lecture was "An Experimental Approach to the Study of the Emotions."

PROFESSOR WILLIAM SEIFRIZ, of the University of Pennsylvania, gave a course of lectures at the Johns Hopkins University on the structure of protoplasm during the first semester, taking the place of Dr. Duncan S. Johnson, who was on leave for duty at the National Research Council at Washington.

THE first annual Sigma Xi day at the University of Rochester, on February 22, was arranged by the local chapter to acquaint the rest of the university and residents of the city with the methods and aims of scientific research and with problems of investigation being conducted by members and their associates. Ninety-five exhibits of current research projects from the scientific departments of the university were on display in the Museum of Natural History from 11 A. M. until 5 P. M., and the exhibitors gave talks explaining their work. In the morning, a lecture intended especially for children was given by Dr. Wallace O. Fenn, professor of physiology, on the subject: "Arms and Legs and How they Work." At night, the society held a formal dinner, followed by an address on "Photography in the Service of Astronomy," by Dr. C. E. K. Mees, research director of the Eastman Kodak Company. Dr. Rush Rhees, president of the university, presided at the evening lecture.

ACCORDING to *Nature* the ninety-first annual general meeting of the British Chemical Society will be held in Glasgow on March 18 under the presidency of Professor G. G. Henderson, regius professor of chemistry in the University of Glasgow, who will take as the subject for his address "The Publication of Chemical Literature." This will be the first official visit of the society to Scotland.

THE House Committee on Foreign Affairs, after hearing on February 24 the director of the U. S.

Geological Survey, Dr. W. C. Mendenhall, deferred action on the resolution to authorize an appropriation of $85,000 for the expenses of the sixteenth session of the International Geological Congress to be held in the United States in June, 1933. Dr. Mendenhall told the committee that there will be from 300 to 500 delegates from foreign countries, and that a program for excursions, to be financed privately, was planned.

THE library of the late Dr. Calvin H. Kauffman, professor of botany and director of the herbarium of the University of Michigan, has been presented to the university by Mrs. Kauffman. It contains 365 volumes and a collection of about six thousand reprints.

ENGLISH exchanges state that owing to the closing of Chillingham Castle, Northumberland, efforts are being made to keep together the herd of wild cattle which is believed to have roamed in the castle enclosure since the thirteenth century. The Zoological Society of London has undertaken to contribute £100 a year for seven years if a lease at £500 a year for that period is granted to three trustees nominated by the society. The remainder of the £500 a year is to be provided by public subscription. The trustees are Lord Grey of Fallodon, Mr. Hugh S. Gladstone and Sir Peter Chalmers Mitchell.

A NEW zoological park "The Provincial Sanctuary and Zoo of Vancouver," is to be established at Vancouver, British Columbia. It is to be entirely for North American mammals and birds and is laid out through natural pine forests connecting two artificial lakes. Enclosures for the exhibits will be placed along trails in the woods. The plan of the zoo was prepared by Mr. C. Emerson Brown, director of the Philadelphia Zoological Garden.

THE Rockefeller Foundation recently granted $250,000 to Vanderbilt University School of Medicine for a research fund, with the understanding that a supplementary amount shall be secured by the authorities of the school. An appropriation of $50,000 has also been made by the General Education Board for the medical library. The research fund will be divided and distributed over a period of eight years, while the medical library grant will be distributed over a period of four years.

THE New York Hospital's new medical center, covering three square blocks along the East River between Sixty-eighth and Seventy-first Streets, is to be opened on September 1. New quarters will be provided for the Cornell University Medical College and a new psychiatric hospital and a new children's hospital will be added to the city's medical facilities. The hospital will have a potential capacity of 1,000. More than half the beds will be available for occupancy at the outset. Equipment and space for medical teaching and special research in all the major fields of medicine will be provided. The Cornell University Medical College will begin to move as soon as its present term ends next June. The college will occupy the buildings joined to those of the New York Hospital on the York Avenue side of the center, between Sixty-eighth and Seventieth Streets. Its fall term will open there on September 29. In its main building, which faces Sixty-eighth Street and rises twenty-six stories to a height of approximately 400 feet above the river, the New York Hospital will devote the two south wings to the public pavilions for medicine and surgery. The north wings will be occupied by the out-patient department and special therapies. The ninth floor will be given over to the James Buchanan Brady Urological Clinic. Private patients are to have a self-contained hospital which will occupy the lower section of the tower, the twelfth to the seventeenth floor. The upper floors are to be used as quarters for the resident medical, surgical and executive staffs.

THE Paris correspondent of *The British Medical Journal* writes: "The congresses are over, and every department of medicine has been discussed. France should now be able to take good care of her population, but, as it was forcibly pointed out at the Congress of Social Hygiene held at Mulhouse, the first necessity is that there should be a population. Exclusive of foreigners the population of France is about 38 millions, roughly the same as it was just before the war of 1870. The population of Germany over this period, however, has increased from 39 to 65 millions, and that of Italy from 25 to 42 millions. The birth rate of France has decreased by more than 30 per cent., and it is probable that it will go on decreasing; this is partly because of the comparatively small number of births during the war, and partly because the younger generation seems strongly in favor of birth control. A declining population is the greatest danger we have to face. The medical profession is doing its utmost to fight infant mortality, and Dr. Devraigne, well known as an ardent protector of both mother and child, showed us a film, which is to travel throughout France, illustrating the principles of hygiene—the care of the child, hygiene in the home, the consequences of alcoholism, protection against infectious diseases, etc. The congress dispersed after having proposed that the government should consider all questions connected with ante- and post-natal care of the mother and child as of the first importance, and, further, that taxation should vary in accordance with the number of children in the family."

Industrial and Engineering Chemistry writes: "The Chemical Laboratory of the American Medical Association, established in 1906, celebrated its twenty-fifth anniversary in October, having functioned continuously for a quarter of a century. The primary reason for its establishment was that the Council on Pharmacy found it difficult to secure satisfactory outside help in checking the composition and properties of newer drugs under investigation and in watching over market supplies of non-official preparations. Since that time the work of the laboratory has been greatly extended, it has aided the medical profession in taking a much more scientific attitude toward drugs, and has rationalized prescribing. It has also been the means of informing the medical profession whether compounds are of the chemical composition claimed. Gross deceit has lessened, though subtle forms of fraud are still practiced. It has been due in great part to the work of the laboratory that the boards of directors of progressive pharmaceutical firms have seen the necessity of maintaining high-grade scientific staffs in order that their products may be carefully watched and freed from criticism and that research may be along lines of genuine value. The laboratory has had a large part to play in scientific nomenclature, in controlling scientific names which twenty-five years ago were in a chaotic condition, and has done its part in developing better methods of standardization and maintaining the best chemical technic and procedure. It has been an aid to public health, in that certain new developments which could not meet its tests have gone no farther than the laboratory."

DISCUSSION

THE GLACIAL CONTROL THEORY APPLIED TO BERMUDA

OUT in the Atlantic Ocean, 675 nautical miles southeast of New York City, stands the submerged volcano making the limestone-covered islands of Bermuda, with their winter resorts, their international biological station, and their naval base of the far-flung British Empire. When this old volcano was active, and when its fires died out, is not known, but presumably at some time in the late Cenozoic. To these beautiful islands Dr. Robert W. Sayles, of the Harvard Department of Geology, went on a vacation trip during the winter of 1923, and in his walks he noted at many places the more or less red residual soils interbedded in the wind-blown dune limestones, now more or less consolidated. Then and there the thought came to him that in these soils, with their living and extinct land snails, might lie the means of correlating these strata with the various epochs of the Pleistocene glacial history of North America. Since then he has revisited Bermuda several times, and now we have his matured considerations, set forth in an interesting memoir[1] that shows much originality and industry. It blazes a new line of endeavor in testing the glacial control theory of Daly, and the method should next be applied to the Bahamas.

The residual soils, Sayles discovered, occur throughout the islands, and they contain 24 described forms of land snails, of which at least 6 and possibly 11 are extinct. These snails furnish the chief means of determining the age of the soils. Probably not enough detailed collecting and study was done to prove beyond a doubt the time correlations. However this may be, many of the local soils are arranged into five named horizons that are separated from one another by the dune limestones, and are correlated with the warm intermediate times between the Wisconsin, Illinoian and Yarmouth epochs of the glacial record. The underlying, much consolidated Walsingham limestone, also largely of dune origin, is correlated with the Kansan and older divisions of the Pleistocene. The underlying basis of interpretation is Daly's Glacial Control Theory, which holds that great quantities of water were subtracted from the oceans to form the continental ice-sheets:

> When the ice was at its maximum extent the strandline fell as much as 260 feet below modern sea-level. While the ice-cap grew, large parts of the Bermuda banks, covered by mollusc shells and unprotected by vegetation, were exposed to the sweep of the winds and the dried sands were piled up in great dunes. . . . When the sea rose at the close of each glacial stage, the source of supply for the dunes was buried beneath the ocean waves, the winds became less violent, and a permanent flora anchored the dunes. A long period of slow decay began, during which red and brown soils accumulated [p. 460].

Accordingly, the Bermudas are considered to have stood highest above sea-level, with the stormiest climate, during the glacial times, causing the formation of the dunes, now consolidated into eolianites, a term here proposed "for all consolidated sedimentary rocks which have been deposited by the wind." During the interglacial warmer times, the sea-level rose and the islands were reduced in size to about their present extent, and this is when the residual soils were formed and the snails entombed.

CHARLES SCHUCHERT

YALE UNIVERSITY

COBALT IN PLANT ASH

IT was observed when vegetables were being ashed for calcium determinations that some gave a white to brown ash, others a green or blue ash. The latter produced a green or blue water solution which turned pink on the addition of hydrochloric, nitric or sulfuric acid. The hydrochloric acid solution soon faded, but the nitric and sulfuric acid solutions retained their color for twenty-four hours.

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[1] "Bermuda during the Ice Age." By Robert W. Sayles. Proc. Amer. Acad. Arts Sci., Vol. 66, No. 11, November, 1931, pp. 379–467, pls. 1–13, text figs. 1–18.

The tendency to form the green or blue ash depends on both the soil and the vegetable. Of the plants grown on the Alabama Experiment Station at Auburn, New Zealand spinach and chard gave an intense green ash; tendergreen and Chinese cabbage gave a medium green ash; while the ash from turnips varied from green in some cases to brown in other cases. Cabbage grown in the greenhouse on Norfolk, Cecil and Hartselle soils gave a green ash of varying intensities; that grown on Eutaw soil gave a white ash. Turnips similarly grown on Oktibbeha soil gave a pale green ash.

Since the Allison apparatus[1] gives one or more light minima characteristic of each compound present and since it will detect approximately four parts in 10^{12}, it seemed a desirable means to determine the cause of the green color referred to above. Several samples of vegetables were ashed, dissolved with hydrochloric acid and examined for the chlorides of iron, chromium, manganese, cobalt, nickel and copper. Cobalt was always absent in the white or brown ash but always present in the green or blue ash, nickel was always absent and the other elements listed above were always present. Hence, it is concluded that the green or blue ash is due to the presence of cobalt. No relation was observed between plant growth and the presence or absence of cobalt in the ash.

We wish to express our appreciation to Dr. Allison for the use of his apparatus and his interest in the work.

EDNA R. BISHOP
MARGARET LAWRENZ
ALABAMA EXPERIMENT STATION,
AUBURN, ALABAMA,
NOVEMBER 25, 1931

THE RELATIONSHIP OF THE GRANITES TO THE RHYOLITES IN SOUTHEASTERN MISSOURI

HAWORTH,[1] in his account of the igneous rocks of Missouri, states that the granites, with few exceptions, grade into the porphyry (rhyolite). He cites many localities where such gradation can be seen and draws the following conclusion. "It is therefore useless to attempt to decide which is the older, the granite or the porphyry." He emphasizes the fact that the granite occurs in the lower ground between the higher hills of porphyry and concludes that the porphyry represents the more rapidly cooled portion at the surface, and the granites and granite porphyries the slower cooled portion deeper down, and that all the rocks belong to the same eruption of igneous material and hence grade one into the other.

This relationship, as interpreted by Haworth, has been accepted by the present Missouri Bureau of Geology and Mines, as is shown by the following quotation from its report on the "Quarrying Industry of Missouri" (p. 61). "The gradation of rhyolite into granite and *vice versa* can often be traced horizontally and vertically."

For many years, I have doubted that a granite in which the grains average nearly one half inch in diameter (which is true of some of those occurring in southeastern Missouri) could change to a dense rhyolite showing flow structure within a few feet, as, under the Haworth gradational theory, would be required by the relationship of many occurrences of these two rocks. It was not until 1919, however, that I found the first positive proof that the granite was instrusive into the rhyolite. This locality was near the top of Knoblick Mountain in St. Francis County, which is in the northeastern part of the area of igneous rocks. The contact found was so sharp and clear-cut that there was absolutely no doubt that the granite was later than the rhyolite and that it was intrusive.

During subsequent years, I have searched for further evidence on the problem, and have been rewarded from time to time by finding other localities where similar relationships exist, although the widespread mantle rock has handicapped the search for actual contacts.

During the last three years, an intensive search throughout the area of igneous rocks of southeastern Missouri has resulted in finding evidence that the granites are not only younger than the rhyolites, but that they were injected into them. Sharp contacts of medium to coarse-grained granites with the dense rhyolites that were undoubtedly surface flows have been found in every locality where the relationship of the two rocks has been determined. This intensive study has shown that probably more than one granite injection occurred, or else that there was marked differentiation within a large intrusive; more probably the former. A detailed account of the relationship of these two rocks was given at the meeting of the Geological Society of America in December, 1931.

W. A. TARR
DEPARTMENT OF GEOLOGY,
UNIVERSITY OF MISSOURI

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[1] Allison and Murphy, *J. Am. Chem. Soc.*, 52, 3796, 1930.

[1] E. Haworth, "The Crystalline Rocks of Missouri," Mo. Geol. Surv., Vol. 8, 84–220, 1895.

THE RÔLE OF CANNIBALISM IN THE SPREAD OF FUNGOUS DISEASES OF GRASSHOPPERS

Fungi of the genera Entomophthora and Empusa have long been known fatally to infest Melanoplus and other genera of grasshoppers. The body of the host remains clinging to the stalk where it died and transmits the disease by allowing the spores of the parasite to come in contact with healthy individuals, and, under favorable conditions, to germinate in their bodies.

Uninfected grasshoppers may themselves aid in the spread of the disease by virtue of a cannibalistic tendency present in certain species. As a demonstration of this tendency, freshly killed individuals of *Melanoplus bivittatus* "planted" along an open path served as bait to attract other individuals of the same species. The cannibals, after making an incision through the first abdominal tergites, would greedily devour the softer substances of the interior of the thorax, leaving the abdominal organs, however, untouched.

Observations made on individuals of this species that had died as a result of parasitism by Entomophthora and Empusa reveal that, although most of them had been untouched by their cospecific cannibals —probably because of the slower rate of dying, or because the bodily odors are more suppressed than in the artificially killed individuals—yet in a few cases the thorax had been hollowed out in precisely the same manner as in the "planted" specimens; and in one instance the act of cannibalism was itself witnessed by the writer. If mere contact, or the chance settling of an Entomophthora or Empusa spore on Melanoplus can bring about infection under the proper conditions (as it unquestionably can), this intimate contact ought all the more to be able to do so; and the moisture transmitted by the dead insect's body to that of the prospective host should make germination of the spores, and the consequent infection, practically certain.

Maurice T. James

University of Colorado

THE IRON-DEFICIENCY HYPOTHESIS IN PELLAGRA

It is desired to correct some misstatements that appeared in an article written by Nellie Halliday.[1] Her reference to an article by Bliss[2] accepts more for his views than he had any intention of claiming, and is, therefore, misleading. Bliss, far from "claiming to show that pellagra . . . and black tongue . . . are both due to an iron deficiency," stated that "none of the considerations here outlined prove that pellagra is an iron deficiency disease," and asserted that he "has adopted the working hypothesis that pellagra is an iron deficiency disease, and has set out to *prove* or *disprove the thesis.*"

One point which Miss Halliday appears to have tried to make is in connection with the probable value of inorganic iron salts in curing the bilaterally symmetrical lesions occurring in rats on a low-iron diet. The failure of $FeCl_3$ in this respect is entirely to be expected, and follows from the results published by Bliss and Thomason,[3] which may have escaped the attention of Miss Halliday. Bliss and Thomason stated that "the addition of ferric citrate to the drinking water or the addition of solid ferric citrate to the food has no demonstrable effect upon the symptoms over a period of months." This finding has been confirmed and reported by others.[4]

Familiarity with living conditions in the south would probably have prevented Miss Halliday from calling attention to the iron content of commercial molasses as an apparent discrepancy in the iron hypothesis. Farmers of the South do not use the concentrated molasses preparations in question, but syrup prepared upon their own farms. Analyses of products subjected to commercial plant manipulations throw no light on the question in hand. Pellagra in the South is essentially a rural problem.

The efficacy of inorganic iron preparations given by mouth has little to do with a decision for or against the iron hypothesis. Work in this laboratory indicates more clearly than before that in pellagra we are dealing with an iron deficiency, but we are refraining from publishing fragmentary announcements until the evidence from many angles can be assembled and evaluated.

For the present we are only desirous that any attempts to refute the iron hypothesis, whether they come from our own laboratory or another, be based upon sound work of a comprehensive character.

Sidney Bliss

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[1] N. Halliday, "The Lack of Correlation between Anemia and the Pellagra-like Symptoms in Rats," Science, 74: 312, 1931.

[2] S. Bliss, "Considerations Leading to the View that Pellagra is an Iron-Deficiency Disease," Science, 72: 577, 1930.

[3] S. Bliss and M. L. Thomason, "Iron Deficiency in the White Rat and the White Mouse," *Proc. Soc. Exp. Biol. and Med.*, 28: 636, 1931.

[4] B. Sure, M. C. Kik, M. E. Smith, "Hematopoietic Function in Avitaminosis. VI., Vitamin G Deficiency," *Proc. Soc. Exp. Biol. and Med.*, 28: 498, 1931.

KREEZER AND DARGE ON AUDITORY ACTION CURRENTS

G. KREEZER and H. DARGE, in the January 22 issue of this journal, have reported their inability to reproduce the results of our auditory nerve experiments. And they suggest the "possibility" that we have neglected one of the more elementary precautions required in an experiment of the kind.

It should be unnecessary to state that this precaution was taken, or to inform Kreezer and Darge that our experiments have been repeated and our results reproduced by Adrian (*J. Physiol.*, 1931, *71*, pp. 28–9 *P*), Adrian, Bronk and Phillips (*ibid.*, 1931, *73*, pp. 2–3 *P*), Davis and Saul (SCIENCE, 1931, *74*, 205–6), Rademaker and Bergansius (*Arch. néerl. de physiol.*, 1931, *16*, 346–9), and Crowe and Hughson (*Zsch. f. Hals-, Nasen- u. Ohrenheilk.*, 1931, *30*, 65–76; *J. Amer. Med. Assoc.*, 1931, *96*, 2027–8).

E. G. WEVER
C. W. BRAY

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE CENTRIFUGE-MICROSCOPE FOR SUPER-CENTRIFUGAL FORCES

IN 1930, Harvey and Loomis[1] described a form of centrifuge-microscope for observing living material while being centrifuged. It consists of a special centrifuge head containing a microscope objective mounted at the circumference under the special slide of living cells. Right angle prisms bring the image to the axis and then vertically upward, where it is observed by an ocular which does not rotate. A high voltage discharge in mercury vapor illuminates the material synchronously with each revolution of the microscope. Although the image is perfect, even at highest powers, the size of the head (2⅝ inches thick, resisting air) offers so much air resistance that speeds over 4,000 r.p.m. (about 2,000 times g at 11 cm radius) can not easily be attained. In recent models the air resistance has been greatly diminished by using objective lenses only and small right angle prisms mounted either between objective and object or between the lenses of the objective system. In this way the thickness of the head has been reduced to ½ inch, and by stream-lining the contours, it is possible to run up to 10,000 r.p.m., giving forces of 12,000 times gravity. This type of head is most suitable for general biological work.[2]

However, it is possible to adapt the microscope-centrifuge principles to the Beams[3] ultra-centrifuge, by which forces approaching one million times gravity can be attained. This scheme is the simplest possible arrangement and has worked out remarkably well, in fact far beyond expectation. No lenses but only mirrors revolve. As shown in Fig. 1 two stellite mirrors (M_1 and M_2) are mounted on the Beams' rotor in such a position that the image of the object on a special slide (S) is brought to the axis and reflected into a microscope (Mic) mounted above and on the axis of the rotor. W. is a counter weight for balancing the rotor. The illumination is a narrow image of the filament of a straight filament tungsten lamp thrown on the material to be observed parallel to a radius of rotation. A relatively large movement at the circumference becomes a very small movement when the image is brought to and observed on the axis of rotation. While the whole field of view is not perfect, the center is good enough for all practical purposes. The magnification of this scheme is limited by the working distance of the objectives; ×5 to ×7 objectives can be used giving with ×20 oculars, 100 to 140 diameters. By mounting lenses on the rotor higher

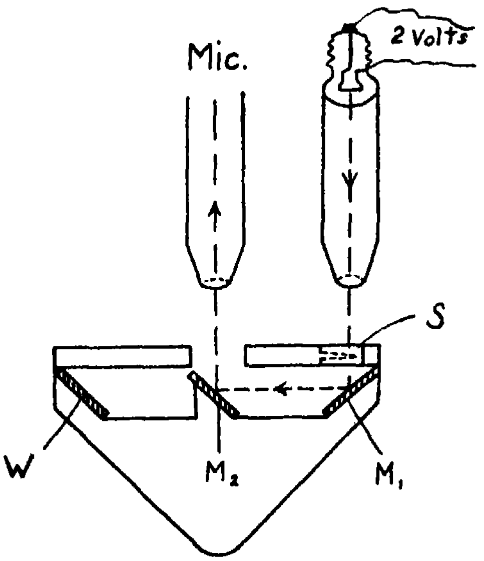

FIG. 1

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[1] E. N. Harvey and A. L. Loomis, SCIENCE, 72, 42, 1930.

[2] The high speed heads were made at the Alfred L. Loomis Laboratory at Tuxedo Park, N. Y. I express my sincere thanks to Mr. Loomis for his generous hospitality and advice during the progress of the work. I am indebted to the Bausch and Lomb Optical Company for lenses and prisms used in developing the new form of head. This company expects to place the microscope-centrifuge on the market in the near future.

[3] J. W. Beams, *Rev. Sci. Inst.*, 1, 667, 1930: SCIENCE, 74, 44, 1931. Dr. Beams and Mr. Weed, of the University of Virginia, have constructed one of the rotors with stellite mirrors which works perfectly.

magnification can, of course, be used. The centrifugal force attainable by means of the Beams' rotor is limited only by strength of materials, and for microscopic observations by this method, is determined by the strength of the glass container of the living cells. This might be put at 200,000 times gravity. Such an arrangement should be particularly useful for determining molecular weights of substances by the method of sedimentation, for observing movement of materials in highly viscous cells and for observing the change in shape of living cells due to the stretching forces of light and heavier material. From such observations one is frequently able to gain an idea of the surface and other forces which counteract distortion.[4] In order that a cell may not be completely crushed by forces thousands of times gravity, it is necessary to adopt the expedient of suspending the material in a medium of graded density, so that the cell comes to lie in a stratum of equal density, and is thereby perfectly cushioned against crushing. Magnified observation of centrifuged material during centrifuging is so easily carried out that the microscope-centrifuge should be a most useful tool in every laboratory.

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A SIMPLE METHOD FOR SEPARATING CERTAIN INSECTS FROM FOOD PRODUCTS

IN connection with the enforcement of the Federal food and drugs act, the writer had occasion, during the raspberry canning season of 1929, to assist in making a survey of the extent of infestation of raspberry fruit by the larvae of *Byturus unicolor* Say. A simple rapid method for the detection of larvae is very desirable for this purpose as well as for determining the fitness of the fruit for food purposes prior to canning. A description of the method as devised is given at this time in the thought that it may be of general use in entomological studies.

Methods of decantation with water were found to be inadequate because the large number of seeds in the raspberries interfered with the rapid detection of the larvae. After considerable experimentation it was found that the incorporation of some oily substance, such as kerosene or gasoline, with the cooked and pulped raspberries caused the larvae to rise to the surface of the subsequently diluted liquid. It was originally thought that the larvae must first be saturated with the oil, and for that reason a method of shaking the oil with a partially diluted pulp in a large Mason jar was devised. While this method gave good results, it was soon found that prolonged shaking was unnecessary, it being essential merely to bring the larvae into contact with the oil-water interface.

The method as recommended for factory testing of raspberries is given below. For other purposes changes will no doubt be advisable. The essential points in detecting the larvae by the use of gasoline or kerosene are: (1) Maceration of the fruit, (2) formation of oil globules throughout the liquid, and (3) careful agitation at end of test to permit all the larvae to come to the top.

The materials required are: (1) Gasoline or kerosene, (2) two No. 10 cans (approximately 3,100 cc each), (3) one No. 2 can (approximately 580 cc), (4) a large spoon or paddle, (5) source of heat, (6) small graduate, (7) forceps and (8) a shallow pan.

PROCEDURE

(1) Fill the No. 2 can with the raspberries to be tested.

(2) Pour berries into a No. 10 can, crush with spoon and cook until soft. If steam heat is used see to it that it is as dry as possible so as not to allow the can to become more than one fourth full of pulp and steam condensate. With dry heat, add enough water to facilitate cooking.

(3) Add 1 to 2 ounces of gasoline or kerosene to the can and stir vigorously.

(Caution: The need of guarding against fire and explosion should not be overlooked.)

(4) Fill the can nearly full with water.

(5) Allow water and pulp to come to rest and examine the surface for larvae. All insects should be picked off with the forceps as soon as located.

(6) Since some of the larvae may be entangled in the pulp, it should be stirred several times, and the surface examined after each stirring. In stirring, the water should be given a rotary movement, then, by placing the spoon in a slanting position along the side of the can, an upward current can be established which helps to bring the larvae to the surface.

Some prefer to pour the contents of the No. 10 can directly into a shallow pan, rinsing out the No. 10 can into the pan and adding enough water to fill the pan to the depth of about 2 inches with liquid and pulp.

(7) As a final precaution, pour the mixture from one No. 10 can to the other, or from pan to can, once or twice, and examine the surface each time for insects.

Insects commonly found in infested foods, in general, respond to the gasoline treatment. This method, or some modification of it, has been found useful in the examination of cereal products, fig paste, spinach and turnip greens, as well as raspberries. Unfortunately the maggot of the cherry fly and of the blueberry fly, and possibly other maggots, do not rise to the surface on such treatment.

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[4] E. N. Harvey, *Biol. Bull.*, 60: 67, 1931; 61: 273, 1931.

Trials of the method have been made during the 1929, 1930 and 1931 seasons by the simple expedient of adding a known number of live larvae to the sample before testing. In only two instances out of 76 trials was there a failure to recover the full number of larvae added.

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SPECIAL ARTICLES

PATERNAL AND MATERNAL INHERITANCE IN FRAGARIA

IRREGULARITIES in the behavior of Fragaria in breeding have been recorded by several investigators. Many cases are recorded where the F_1 seedlings have the characteristics of the female parent only, while a few cases are mentioned by Millardet[1], Solms-Laubach[2], Longley[3] and Ichijima[4], where the F_1 seedlings have the characteristics of the male parent only. In all the cases where pure maternal or paternal inheritance has been observed by the various writers, the seedlings have been crosses between parents having different chromosome numbers. That this type of inheritance also occurs in cases where two plants with the same number of chromosomes are crossed is shown by results obtained at the Oregon State Experiment Station at Corvallis, Oregon.

Several different selections of the wild field strawberry, commonly known as *Fragaria cuneifolia,* were crossed with horticultural varieties by C. E. Schuster in 1929. These were set in the field in March, 1930, and the results were observed in May and June, 1931. One set of crosses consisted of the horticultural variety Gold Dollar[5] (derived from *F. virginiana* x *F. chiloensis*) x *F. cuneifolia,* both of which have 28 chromosomes. In a set of 2,015 seedlings there were 37 plants which showed paternal inheritance only. In a set of 420 plants of Ettersburg 121 x *F. cuneifolia* there was one plant that showed apparently pure paternal inheritance and three that were doubtful. A set of 948 plants of the cross U. S. D. A. No. 147A x *F. cuneifolia* contained two plants with apparently pure paternal inheritance and seven dwarfs. In all there were 43 plants with paternal inheritance only out of 3,519, or 1.2 per cent.

In addition to the above crosses, using *F. cuneifolia* as the male parent, there were two sets of crosses in which pistillate selections of this species were used as the female parents. In a set of 207 plants of the cross *F. cuneifolia* x Gold Dollar, there was one plant with apparently pure maternal inheritance. The flowers were pistillate but sterile. Another selection of *F. cuneifolia,* also crossed with Gold Dollar, contained one plant which appeared to be pure paternal in inheritance in a set of 216 plants. There was also a set of 216 plants of the cross Corvallis x *F. cuneifolia* which had no cases of pure maternal or paternal inheritance that could be detected.

The plants which showed the inheritance from the species (*F. cuneifolia*) parent only were much smaller than the true hybrids, and had all the plant characters of the wild species. A single typical plant of each of the two types in the set of Marshall x *F. cuneifolia* crosses was measured with the following results:

	Plant with pure paternal inheritance	True cross
Fresh weight in grams	130	700
Number of leaves	67	105
Average size of leaves, sq. cm.	16.6	106
Total leaf area, sq. cm.	1,109	11,130

These figures are from only one plant of each kind, but they were representative of the lots and the figures are sufficiently striking to show the difference between the types.

The true hybrids were large vigorous plants, showing the effect of hybrid vigor. Almost without exception they were larger than most of the crosses between cultivated varieties. One plant of the cross Ettersburg 121 x *F. cuneifolia* had as many as 1,352 flowers on it. They showed considerable variation, but were intermediate in most characters between the types of the two parents. The plants with the pure paternal or maternal inheritance of the species were almost or entirely sterile, but the berries produced were distinctly of the type of the species.

No chromosome counts have been made on these plants, and it is not known whether the haploid or diploid number prevails in the somatic tissue of the plants showing inheritance from only one parent. If only one nucleus went into the make-up of the plants the number could have been reduced to haploid through the lack of conjugation, or the diploid number may have been restored by doubling in microsporocyte, as suggested by Ichijima.

It is easily possible that this type of inheritance is common in the crossing of strawberry varieties but that it has not been recognized because of the similarity of the parent plants used. In the cases reported here, the parent plants were so strikingly different in size and appearance, in spite of their having the same number of chromosomes, that paternal and maternal inheritance could be easily recognized. The knowledge that this type of inheritance can be obtained from crossing two plants of the same chromosome number which readily hybridize is useful in making studies on inheritance, and it will obviate the necessity of working with crosses between plants of different chromosome numbers which are rather difficult to obtain.[6]

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[1] A. Millardet, "Note sur hybridation sans croisement ou fausse hybridation." *Mem. Sci. Phys. et Nat. Bordeaux,* 1894, 4 ser., IV: 347–372.

[2] H. Solms-Laubach, "Uber unsere Erdbeeren und ihre Geschichte." *Bot. Ztg.* 65, 1 Abt. 45–76, 1907.

[3] A. E. Longley, "Chromosomes and Their Significance in Strawberry Classification," *Jour. Agr. Res.,* 32: 559–568, 1926.

[4] K. Ichijima, "Studies on the Genetics of Fragaria," *Zeitschrift für Induktiv Abstammungs und Vererbungslehre,* Bd. L V, Heft 4: 300–347, 1930.

[5] In all references to strawberry crosses the female parent is mentioned first.

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PASSIVE IMMUNITY TO INFECTION WITH A LARVAL TAPEWORM OF THE ALBINO RAT[1]

THE results of a preliminary experiment show that the albino rat can be protected against infection with onchospheres of a cat tapeworm, *Taenia taeniaeformis*, by transfer of serum from immunized rats. This appears to be the first demonstration of transfer of what are probably circulating antibodies resulting from intra-peritoneal injections of cestode material.

It has been shown[2] that an active acquired immunity against infection by onchospheres of *T. taeniaeformis* can be artificially produced in the albino rat as a result of a standard series of six intra-peritoneal injections of a 1 per cent. suspension of powdered worm material of the same species. Complete or almost complete inhibition of development of *Cysticercus fasciolaris* (larval stage of *T. taeniaeformis*) in the liver of the rat resulted from the injections; while cyst development took place normally, for the most part, in control animals. Such artificially immunized rats were used in the present experiment as a source of the serum which was donated to the experimental rats. Thirty-four rats were given the standard series of injections from July 24 to August 8, 1931; they were reinjected with 2 cc of a 1 per cent. suspension of worm material on October 5 and 7. Serum was collected on October 9 and used the following day; normal serum from stock rats was also obtained on October 9.

Fifty-nine rats from 6 litters born May 16 to June 1, 1931, were used; individuals of each litter were distributed through three groups: one (Group A, 22 rats) to receive immune serum; another (Group B, 12 rats), normal serum; and the third (Group C, 25 rats) untreated. All rats were infected with equal portions of a uniform suspension of onchospheres, and the injection of serum begun 2 hours later. The rats of Group A received either 2.5 cc or 7 cc of immune serum intra-peritoneally, and those of Group B either 3 cc or 7 cc of normal serum. All animals were autopsied 34 to 38 days after infection. The data are shown in the following table.

Further experiments are in progress.

	Treatment	Number of rats	Average number of cysts	
			Living	Dead
Group A	7 cc immune serum	10[3]	11	25
		2	142	8
Group A	2.5 cc immune serum	3	12	46
		7	110	19
Group B	3 cc or 7 cc normal serum controls	12	167	14
Group C	Uninjected controls	25	276	16

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BOOKS RECEIVED

Bulletin of the Museum of Comparative Zoology. *Classification of Insects.* CHARLES T. BRUES and A. L. MELANDER. Vol. LXXIII. Pp. 672. 1121 figures. The Museum.

CAYLEY, NEVILLE W. *What Bird is That?* Pp. xix + 319. Illustrated. Angus and Robertson, Sydney. 12/6.

GREAVES, JOSEPH E. and ETHELYN O. GREAVES. *Elementary Bacteriology.* Second edition. Pp. 535. 138 figures. Saunders. $3.50.

KENLY, JULIE C. *Children of a Star.* Pp. xi + 242. Illustrated. Appleton. $2.50.

KIPPING, F. STANLEY and E. BARRY KIPPING. *Organic Chemistry.* Pp. xi + 614 + xxix. 24 figures. Lippincott. $3.50.

LONG, J. S. and H. V. ANDERSON. *Chemical Calculations.* Third edition. Pp. ix + 259. 16 figures. McGraw-Hill. $1.75.

Report of the Library of Congress for the Fiscal Year, 1931. Pp. viii + 463. Illustrated. U. S. Government Printing Office.

ROBSON, G. C. *A Monograph of the Recent Cephalopoda.* Pp. xi + 359. Illustrated. British Museum (Natural History), London. £1.

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[6] Published as Technical Paper No. 157, with the approval of the director of the Oregon Agricultural Experiment Station, a contribution of the department of horticulture.

[1] This investigation was in large part made possible by a research grant made to Washington University by the Rockefeller Foundation.

[2] H. M. Miller, Jr., *Proc. Soc. Exp. Biol. and Med.*, 27, 926, 1930; *Jour. Prev. Med.*, 5, 429, 1931.

[3] No living cysts present in four rats.

SCIENCE

VOL. 75 FRIDAY, MARCH 11, 1932 No. 1941

The Maya Lunar Count: DR. CARL E. GUTHE 271

Obituary:
Edward Orton, Jr.; Recent Deaths 277

Scientific Events:
Anti-vivisection Activity; The American School of Prehistoric Research; The New York Association of Biology Teachers; The Southwestern Division of the American Association for the Advancement of Science; The Pacific Division of the American Association for the Advancement of Science 279

Scientific Notes and News 281

Discussion:
Direct Financing for Basic Scientific Research: PROFESSOR W. C. CURTIS. *The Supervision of Student Research:* DUANE ROLLER. *Vitamin A and the Iodin-fat Balance:* DR. F. E. CHIDESTER. *The Feeding Habits of the First Instar Larvae of the Cluster Fly:* DR. R. M. DECOURSEY. *Branchinecta Coloradensis in Colorado:* PROFESSOR KENNETH GORDON. *A Temporary Respite for the Whale:* DR. C. H. TOWNSEND. *Epizootiology:* E. L. TAYLOR 284

Special Correspondence:
European Excursions in 1932: PROFESSOR O. A. JOHANNSEN 289

Scientific Apparatus and Laboratory Methods:
A Microscope for Observation of Fluorescence in Living Tissues: DR. EDWARD SINGER. *An Improved Prospecting Pick:* DR. BARNUM BROWN. *A Quick Method of Embedding Soft Material in Celloidin:* PALMER STOCKWELL 289

Special Articles:
Trichromatic Functions of the Average Eye: DR. W. F. HAMILTON and ELLIS FREEMAN. *Chemical Composition of Rice and its Relation to Soil Fertility in China and Japan:* DR. JEHIEL DAVIDSON and C. E. CHAMBLISS 292

Science News 10

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THE MAYA LUNAR COUNT[1]

By Dr. CARL E. GUTHE

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MY subject concerns certain aspects of the indigenous calendar of the Maya Indians of Middle America. This time count consisted of named days and months associated with short number series which, in principle, is closely similar to our own calendar. The dates thus obtained, analogous to our term "Tuesday, the 29th of December," were located, during the earlier period of their civilization, in a count of days from an hypothecated starting point in a manner identical to the system used by European astronomers when they compute in terms of "Julian days." Because of this "Long Count" the many dates recorded in stone during the earlier period are accurate to within a day with relation to one another. For further details concerning the mechanics of this calendar, I refer you to a number of publications.[2]

An outline of the history of the remarkable Maya civilization has been obtained in terms of this native calendar. Because of the influence which this group of people exerted both directly and indirectly upon the majority of the indigenous civilizations of the New World it is of great importance that the Maya calendar be expressed in terms of the European calendar. The problem is to determine the numerical constant which must be added to the Long Count to obtain the equivalent Julian Day.

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[1] Address of the vice-president and chairman of Section H—Anthropology, American Association for the Advancement of Science, New Orleans, December 29, 1931.

[2] S. G. Morley, "An Introduction to the Study of the Maya Hieroglyphs," Bureau of American Ethnology, Washington, Bulletin 57, 1915; H. J. Spinden, "The Reduction of Mayan Dates," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, Vol. vi, No. 4, 1924; J. E. Teeple, "Maya Astronomy," Carnegie Institution of Washington; Contributions to American Archeology, No. 2, Publication 403, pp. 29–115, 1930.

Offhand, the obvious suggestion is to search early Spanish records for a statement of a date in both calendars. Unfortunately, the Mayas had abandoned the use of the Long Count before the Spaniards encountered them. Such dates as are given in both calendars give only the Maya cyclic dates, which repeat themselves at regular intervals in the Long Count. The interpretations of these data offered by specialists give several different values for the constant to which I have referred, the two most acceptable ones differing from one another by nearly 260 years. This situation has given rise to what is technically known as the "Correlation Problem."

Since the post-contact records are inconclusive in themselves, it is necessary to seek additional data in the more ancient inscriptions in which the Long Count is recorded. The only phenomena which were surely observed by both the Maya Indians and the Europeans prior to the sixteenth century were astronomical. Hence such Maya records as appear to be of this character have undergone a severe scrutiny. The technical problems involved excited my interest, and have caused me to review at least some of the indigenous records referring to the moon.

The problem before us is such that two specific questions concerning the Maya records of the moon are of particular importance. The first of these is, "What phase of the moon was used as the beginning of the Maya lunar month?" and the second "Did the Mayas, during the period of the inscriptions, use a computed calendar which approximated the periodicity of lunations, or did they record the beginning of the lunar month from direct observation?" These are the two questions I lay before you.

The first of these may be studied from several viewpoints, namely, customs of similar civilizations, the European-Maya records, and the indigenous native records. A survey of lunar calendars over the world discloses that while a majority of them contain months beginning at the new moon phase, several use the full moon phase for this purpose. Since both customs do exist we must dismiss this line of attack as failing to yield conclusive data.

As far as I know now, the only definite statement on this subject yet found in the early Spanish records is made by Bishop Landa, the first Bishop of Yucatan, when he states that the Mayas counted from the time the new moon rises till it disappears. Certain statements made by the Bishop on a number of subjects have been either accepted or proved as correct. At first sight, then, this would appear to be good evidence. A further consideration reveals that some of Landa's statements are incorrect. Moreover, all the Spanish records are subject to the criticism that they record the interpretation of a native civilization by a group of persons tending to be unsympathetic towards non-European customs, influenced by European habits, and untrained in obtaining accurate ethnological records. Dr. Ludendorff suggests that this record of the new moon as the beginning of the lunar month may be the result of a leading question on Landa's part, which is possible.[3] Therefore, with all due consideration for Landa's mental honesty and acumen, which is so clearly illustrated in his work, we must conclude that while this evidence is more probably correct than false, we can not consider it as conclusive.

European records of associated and later times should also be considered. Dr. Willson has written, "the fact is known that the ancient Mexicans did not make use of lunar eclipses,"[4] but does not give his source for the statement. Of course lunar eclipses can only occur at time of full moon. Dr. Willson used solar eclipses in his work, which meant that he supported the use of the new moon as the beginning of the lunar month. It is probable that his statement is based upon early Spanish sources from Mexico, which may be more definite, but to which the additional objection may be raised that they concern a different, even though closely related, civilization. In short, the evidence from other European records is also not definitive.

There remain the data from the native records, *i. e.*, the inscriptions and the manuscripts. The only apparent clue to this problem in the inscriptions was suggested by Mr. J. E. Thompson in the course of a conversation during the past month, and embodied in a letter to me from which I quote: "The lunar glyphs themselves might be construed as possible evidence of the Maya lunar count of the inscriptions having started from new and not full moon.

"Glyph C represents a completed moon, but the lunar element of this glyph is of crescentic shape. If the lunar month was completed at new moon one would expect the moon to be shown as crescentic, but if the moon was completed at full moon, one would expect Glyph C to show a full moon. Such is not the case. Similarly, if the moon count starts at new moon, one would expect Glyph D to be represented by a new moon; but if the lunar month starts at full moon, one would expect the full moon element to occur in Glyph D. Actually it is shown as crescentic. Glyph E, following the Maya vigesimal count, represents twenty days after the start of the lunar month. If this is counted from new moon, Glyph E should be a full moon, since at 20 days after new moon, the moon is considerably closer to full than to crescentic. If the count was from full moon, Glyph E, on the same line of argument, should be shown as crescentic. Actually it is shown as full. Glyph A, of course, is nothing more than Glyph E with a coefficient placed in a different position. This does not denote addition, as has been suggested, for in that case Glyph E would also have its coefficient placed below or to the right. I think this change in the position of the coefficient serves to differentiate Glyph A from Glyph E.

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[3] H. Ludendorff, "Das Mondalter in den Inschriften der Maya," Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-Math. Klasse, 1931, iii.

[4] R. W. Willson, "Astronomical Notes on the Maya Codices," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, Vol. vi, No. 3, 1924.

"This evidence of the glyphs themselves is not conclusive, but does, I think, give support to the thesis that the Maya lunar count of the inscriptions started from new moon." Mr. Thompson's suggestion is valuable, and in accordance with our admittedly inadequate knowledge of Maya psychology. It is still only a hypothesis and can not be considered irrefutable until a careful comparative analysis has been made of all existing examples of these glyph forms.

A somewhat indirect form of evidence is found in the manuscripts and has been referred to by Dr. Teeple.[5] There is reason to believe that the Maya Venus count was from the time the new Venus appeared after conjunction with the sun. By analogy, according to Teeple, we expect the moon count to be from new moon immediately after conjunction. Dr. Willson explains the Venus configuration referred to and adds "This conjunction is called 'inferior conjunction' and is much more striking than that between second heliacal rising and first heliacal setting on account of the great brilliancy of the planet and of the rapidity with which it passes from evening star to morning star."[6] Both Drs. Spinden and Ludendorff feel that the analogy is not well taken, but give no specific reasons.[7] The analogy between the two phenomena which Dr. Teeple probably had in mind was the first appearance of both celestial bodies after conjunction with the sun. But with that, the analogy ceases, for the actual observational phenomena do not seem to be similar, because Venus, after inferior conjunction, first appears on the eastern horizon just before sunrise, and, rising earlier each day, appears to be moving westward away from the sun with the passage of time; while the moon, after conjunction, first appears as a crescent on the western horizon just after sunset, and, rising later each day, appears to be moving eastward away from the sun with the passage of time. The validity of the analogy is a matter of opinion, and does not serve, therefore, as conclusive evidence.

This discussion raises a point which, as far as I know, has never been discussed. If the Maya began their Venus count when Venus first appeared as morning star just before dawn, is it possible that the lunar month was begun on the day that the crescent moon was last seen in the east just before dawn—that is, just *before* the moon's conjunction with the sun? If such were the case, Mr. Thompson's suggestion would be strengthened, for then full moon would be more nearly twenty days after the beginning of the lunar month.

The final group of data applicable to this question is found in the lunar table of the manuscripts. The following brief statement of the characteristics of this table on pages 51 to 58 of the Dresden Codex contains only such points as are agreed upon by all students. It consists of a series of numbers constantly increasing in value by intervals of 148, 177 and 178 days. We know these intervals refer to days because associated with each total are the proper three consecutive days from the repeating 260-day calendrical cycle. The three intervals are close approximations of five and six lunations and are so arranged that the recorded totals agree with modernly computed eclipse intervals with an error of not more than one day over a total period of 11,960 days, slightly more than 33 years. The record is unquestionably an eclipse record, and therefore the intervals were counted from either new or full moon, the only phases at which eclipses can occur. Is there any internal evidence to show to which phase of the moon the table refers?

Before proceeding further it is necessary to present certain data concerning eclipses as used in modern astronomy, and tabulated in Oppolzer's canon.[8] Examination of these tables, without reference to a specific locality, makes apparent at once that there is a definite periodicity in the phenomena. Lunar eclipses may occur at six lunation intervals five, six or seven times in succession. Then follows a period of no eclipses which usually covers 17 lunations, but sometimes only 11. This is followed again by lunar eclipses at six lunation intervals. There is also a larger periodicity permitting a grouping of 88, 94, 135, 223, 270 and other multiples of lunations.

The situation with regard to solar eclipses is similar. Such eclipses occur at six lunation intervals five, six or seven times in succession. In the intervening 17 lunation periods there may be three to five eclipses at 5, 6, 11, 12 and 17 lunations. Those within one lunation of each other are never visible at the same point on the earth. It is clear that since these smaller intervals are the same as in lunar eclipses the larger groupings apply equally well to both solar and lunar eclipse phenomena.

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[5] Teeple, *loc. cit.*, p. 49.

[6] Willson, *loc. cit.*, p. 9.

[7] Ludendorff, *loc. cit.*, 1931, p. 13; H. J. Spinden, "Maya Dates and What They Reveal," The Museum of the Brooklyn Institute of Arts and Sciences, *Science Bulletin*, Vol. iv, No. 1, 1930, p. 41.

[8] Th. von Oppolzer, "Canon der Finsternisse," Denkschriften Keiserl. Akad. Wissensch. Math.-Naturw. Klasse. lii, Wien, 1887.

It is relatively simple to explain the absence of lunar eclipses over a 17 lunation period, and the presence of solar eclipses in a similar period by modern astronomical knowledge, and an exposition of the concept of the "moon's node." The manuscript lunar table contains five lunation intervals, but no definite 11 or 17 lunation interval.

Dr. Teeple has presented a detailed and scholarly exposition of the thesis that the table can only be a solar eclipse table.[9] By plotting the dates given in the table upon a chart showing their occurrence in the 260-day calendrical period, two of which closely approximate one and one half eclipse years, he demonstrates that certain of the dates given fall beyond the limits of possible lunar eclipses, but are possible dates for solar eclipses. He reasons that, since these dates are recorded, and since a variation in the symmetry of the table in the last third prevents one of them from falling beyond the limits of solar eclipses, the table definitely concerns solar rather than lunar eclipses.

There is no single locality at which all solar and lunar eclipses are visible. Speaking in general, solar eclipses are more frequent than lunar ones, but with reference to a single locality, lunar eclipses are far more frequent than solar ones because of the narrow paths of the latter. From a knowledge of eclipse phenomena with reference to a specific locality it is evident that eclipses of either kind could not have been visible in the Maya area at each of the dates given in the manuscript in succession. The manuscript lunar table is, then, a compendium of eclipse knowledge, irrespective of the question of whether or not it refers to a specific series of eclipses. A number of the dates in the text could not record eclipses during any given 11,960 day period.

Since the 135 and 405 lunation interval is equally applicable to the periodicity of both types of eclipses, it is possible to coordinate the manuscript table with lunar eclipses. When this is done and the lunar eclipse dates charted upon a form similar to that used by Dr. Teeple, it is found that those dates on which no lunar eclipses can occur are those adjacent to the 148-day intervals in the manuscript, *i.e.*, the 11 or 17 lunation period is represented in the table by one or two six-lunation groups and a five-lunation group. This situation is characteristic of each of every one of the five-lunation groups.

It is known that the Mayas counted by six-lunation intervals several centuries prior to the creation of this table. Since the table corresponds so closely to eclipse phenomena, the Mayas probably knew of the 11 or 17 lunation interval without lunar eclipses. Because of the Maya habit of grouping in six-lunation groups, and knowing that every group in the table could not represent an eclipse date at any given time, the division of the 11 or 17 lunation interval into one or two groups of six lunations and one of five lunations is to be expected. The only other way of constructing a lunar eclipse table of this type would be to use the 11 or 17 lunation interval as a unit between groups of five, six or seven intervals of six lunations each. It might even be argued that the relation to solar eclipses of those dates adjacent to the five-lunation interval is only a coincidence, were it not for the conspicuous display in the "introduction" to this table, of Tzolkin dates fifteen days apart, covering, a two-lunation interval. I assume it is clear that, since solar and lunar eclipses can only occur at new or full moon, the interval between any given solar and the nearest lunar eclipse is a multiple of complete lunations plus approximately fifteen days.

It is evident, then, that the lunar table in the manuscript may be correlated with either solar or lunar eclipses. This has been done for solar eclipses by Drs. Willson[10] and Teeple,[11] and for lunar eclipses by Dr. Ludendorff.[12] Dr. Willson found that noteworthy coincidences between the manuscript record and the modern table of solar eclipses occurred seventeen times in about fifteen centuries.[13] Dr. Ludendorff placed the manuscript lunar table at one point in the Julian Day count at which there is complete agreement with lunar eclipses, except for one date. Had he placed it 3,987 days earlier he would have had complete agreement. He also found that equally satisfactory agreement could be obtained at 46 places over a period of about 400 years.[14]

The lunar table of the manuscripts, therefore, not only fails to give conclusive evidence regarding which phase of the moon was used as the beginning of the Maya lunar month, but also is found to be an eclipse table so accurately computed and so complete that it can be integrated into the Julian Day count at a large number of places, and still be in agreement with either solar or lunar eclipses. It is a computed table rather than a table of observed phenomena.

Our investigation of the question whether the

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[9] Teeple, *loc. cit.*, pp. 86–93.

[10] Willson, *loc. cit.*, pp. 13–16.

[11] Teeple, *loc. cit.*, pp. 87–91.

[12] H. Ludendorff, ''Uber die Reduktion der Maya-Datierungen auf unsere Zeitrechnung,'' Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-Math. Klasse. 1930. xviii, pp. 7–9.

[13] Willson, *loc. cit.*, p. 16.

[14] Ludendorff, *loc. cit.*, 1930, p. 9.

Mayas counted lunar months from new or full moon has revealed that the data at present available in comparative chronology, European-Maya records, and indigenous Maya records are not conclusive. It is clear that the phases of the moon at which eclipses might occur were used as the starting point for the Maya lunar month. But no irrefutable evidence has yet been found to indicate which of the two phases of new or full moon was used. The major part of the evidence tends to indicate that the Maya probably began their lunar months at new moon, but no proof of this has yet been found.

Therefore, the exclusive use of either phase of new or full moon as the beginning of the Maya lunar month is not a valid premise at the present time upon which to base conclusions concerning Maya astronomical records.

In considering the question of the existence of a computed lunar calendar at the time of the inscriptions it is necessary to analyze the available data. In order to simplify the problem I have used only the following two groups of indigenous data:—the manuscript lunar table and the Supplementary Series records during the Period of Uniformity, which have been made available in convenient form in Dr. Teeple's Table 3.[15] The following adjustments have been made in this table: Two dates have been omitted because of apparent contradictions, namely, those on Lintel 26 at Yaxchilan and on Lintel 1 at El Cayo; Two dates have been added, The Temple of the Initial Series No. 15 at Holactun, using Mr. Thompson's reading 9.15.12. 6. 9,[16] and Lintel 3 at Piedras Negras, newly discovered and beautifully exhibited by the University of Pennsylvania Museum. It bears the date 9.15.18. 3.13.

The manuscript gives an arrangement of five- and six-lunation groups, containing 148, 177 and 178 days. The inscriptions record that during the Period of Uniformity the lunations were arranged by sixes only.[17] Combining these two groups of data gives the first premise; During the Period of Uniformity the Maya lunar count was in groups of six lunations each, containing either 177 or 178 days, and an additional period of five lunations containing 148 days was used at the time of the writing of the manuscript.

The manuscript contains no information concerning any subdivisions of these groups. Glyph A of the Supplementary Series does record that these groups were divided into months of 29 and 30 days. There is no evidence of the use of any months of either 28 or 31 days.

Dr. Teeple gives a free reading of a combined Initial Series and Supplementary Series, from which I quote the interpretations of glyphs E, D, C and A: " . . . the age of the moon is 20 days from the last new moon, and it is 20 days and one moon since this lunar half year began; . . . and this present moon will probably end as a 30-day moon."[18] You will note that he includes a reference to new moon, which I feel is not justified. The readings of glyph E, D and C are in terms of elapsed time, that of glyph A in current time. The data of the Maya calendar are overwhelmingly in favor of the assumption that the Mayas counted in elapsed time only, at least during the days of the Old Empire. I therefore suggest a revised translation of these sections, as follows: " . . . the age of the moon is twenty days from the end of the last lunar month; there has been one complete month since the ending of the last lunar half-year; . . . the last complete month contained 30 days."

Dr. Teeple has pointed out that "Whenever glyph C has an odd coefficient, 1, 3 or 5, the chances are about three to one that glyph A will show 30 days; whenever glyph C has an even coefficient, 2, 4 or 6, the chances are about three to one for a 29-day glyph A."[19] If my reading of glyph A is correct, then this relationship indicates that normally the six-lunation periods were divided into six months arranged in alternation containing 30, 29, 30, 29, 30, 29 days each, thereby closely approximating actual lunations in terms of whole days. Moreover, such an alternation creates the totals of 177 and 148 for the lunation groups as found in the manuscript. My second premise is then: The five- and six-lunation groups were normally divided into an alternating series of 30 and 29 days, beginning with one of 30 days.

The manuscript lunar table states that at the time it was made the Mayas computed that 405 lunations equalled 11,960 days. Dr. Teeple has demonstrated that during the time of the inscriptions the Mayas used the equivalents of two other computations, namely, 149 lunations equaled 4,400 days, and 81 lunations equaled 2,392 days.[20] But an unbroken alternation of 30 and 29 day months for these periods give respectively 11,948, 4,396 and 2,390 days, *i. e.*, 12, 4 and 2 days less than the Maya records show. The Maya computations approximate the true lunation intervals more closely than the straight alternation. They must therefore have added intercalary days probably at more or less regular intervals. The existence of 178-day groups in the manuscript and the occurrence of two cases of even months with 30 days in the Supplementary Series supports this conclusion.

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[15] Teeple, *loc. cit.*, pp. 50–51.

[16] J. E. Thompson, "Archeological Investigations in the Southern Cayo District, British Honduras," Field Museum of Natural History. Publication 301; Anthropological Series, Vol. xvii, No. 3, 1931, pp. 354–356.

[17] Teeple, *loc. cit.*, pp. 53–61.

[18] *Ibid.*, p. 64.

[19] *Ibid.*, p. 63.

[20] *Ibid.*, pp. 64–67.

Since no record exists of 179- or 180-day groups, and since no record exists of 31-day lunar months, my third premise is: The Mayas never added more than a single intercalary day in any six-month group, and this was done by changing a 29-day month to a 30-day month.

The only data we have which may indicate the intervals at which the intercalary days were added is contained in the manuscript table. Such isolated examples of even numbered months of 30 days in the Supplementary Series are too widely separated in time to be of assistance. Following the method used in my article on the manuscript lunar table,[21] an alternating series of 30 and 29 days can be applied to this record, and the intercalary days arbitrarily added in such six- and five-month groups as are necessary to have the sequence conform to the totals given in the table. If the alternation is applied in 135-month groups, it is found that the intercalary days may be added in the same months in each third of the table, namely, the 32nd, 74th, 80th and 130th months. Unfortunately, there is no indication of which 29-day month in each group contained the intercalary day, so the possibility of the use of one of the other two 29-day months in each six-month group for this purpose must be kept in mind. Due to irregularities which must be taken into consideration it is necessary to use the entire 11,960-day table rather than one of one third this length.

But the manuscript table can not be applied to the record of the inscriptions as it stands because of the existence of five-month groups, which were not used during the Period of Uniformity. We can, however, group the month table which has been made to fit the data of the manuscript into six-month groups only, without altering either the sequence or the value of the months. 135 and 405 months are not divisible by six, but twice each of these periods are respectively 45 and 135 six-month groups, by the use of which a repeating cycle in six-month groups will be obtained. The six-month groups of the second, fourth and sixth thirds of the manuscript table begin with a 29-day month instead of a 30-day month, in disagreement with a part of my second premise.

It is, of course, clear that I am preparing to apply the manuscript lunar table to the record of the Supplementary Series. This latter record must also be analyzed. Glyphs E, D and C give the age of the moon at the time of the related Long Count date, in terms of months and days since the end of the last lunar half-year. In translating the months into days we must consider the possibility that any one of the 29-day months may have contained an intercalary day. Therefore, wherever glyph C records more than one month, we must use two adjacent values for the number of days corresponding to the month record. For example, if glyph C records three months, the number of days would normally be 30 + 29 + 30 or 89 days, but if the 29-day month contained an intercalary day, there would be 90 days in the three months. By subtracting the record of glyphs E, D and C from the associated Long Count date, the "lunar base" or the end of the last complete lunar half-year is obtained in terms of two adjacent dates in the Long Count.

We now have a table of months arranged in terms of lunar half-years, which conforms to the data of the manuscript lunar table, and a series of dates in the Long Count which record the ending of lunar half-years during the Period of Uniformity. These two groups of data may be charted in terms of lunar half-years and compared directly, by a method similar to that used by Dr. Willson.[22] In order to prevent confusion, the dates from the various cities have been charted separately.

There are 28 dates between 9.13. 5. 0. 0 and 9.16. 1. 0. 0 which conform to the requirements of the Period of Uniformity, and no dates which do not do so. Thirteen of these occur at Piedras Negras, giving us the best critical series for a test. The application of the manuscript lunar table in terms of 30- and 29-day months fits this group of dates from Piedras Negras exactly, with a single exception, that on Stela 5, where the reading for glyph D is uncertain. Dr. Teeple says of it, "the age is surely over 10 and not over 15, while 15 is expected."[23] The manuscript table demands glyph D have the number 16. A very slight adjustment in the manuscript table of the intercalary day in the 130th month of the sixth third will eliminate this possible error.

There is a day-for-day agreement, except for a single doubtful reading, between the record of glyphs E and D in the inscriptions at Piedras Negras during the Period of Uniformity, and a month-for-month arrangement of the manuscript lunar table.

When the entire range of the Piedras Negras dates conforming to the Period of Uniformity is considered, we have 19 dates ranging over a period from 9.11.12. 7. 2 to 9.18. 0. 3. 1, a total of 45,999 days, or nearly four times the length of the manuscript lunar table. There are only four of the 19 dates which do not give an exact correlation, and all four record a difference of only one day from that expected. In each case this error of one day is adjusted during the next few lunar half-years of the table.

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[21] C. E. Guthe, "A Possible Solution of the Number Series on Pages 51 to 58 of the Dresden Codex," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University. Vol. vi, No. 2, 1921, pp. 21–24.

[22] Willson, *loc. cit.*, pp. 13–15.

[23] Teeple, *loc. cit.*, p. 52.

A similar examination of the four dates at Naranjo reveals complete agreement without exception. Of the seven dates at Copan, five are in exact agreement, and the other two are one and two days at variance respectively, but again are corrected during the following few lunar half-years. The starting date for the lunar table is a different one for each city. At Piedras Negras it is the lunar base for 9.12. 2. 0.16, which is recorded twice with different moon ages, and at Copan it is the lunar base for 9.12. 8. 3. 9, which is used as the basis for lunar computations on Altar H′.

At Piedras Negras two monuments record Initial Series identical to two at Copan. In the first case, 9.13.10. 0. 0, the moon age at Piedras Negras is given as two days more than at Copan. In the second, 9.15. 5. 0. 0, identical moon ages are recorded. All four of these dates fit exactly into the manuscript month series. The apparent contradiction is caused by the fact that the month grouping used is engaged into the Long Count at different points in the two cities.

It is demonstrable, therefore, that a 135-month cycle of 30- and 29-day months, so arranged as to conform to the groups of the manuscript lunar table, may be applied to the records of the inscriptions in such a way as to cause a day-for-day agreement between it and the records given in glyphs E, D and C of the Supplementary Series, with a very few exceptions, which are all corrected in succeeding lunar half-years. At Piedras Negras this 135-month cycle must be repeated twelve times.

As it is used, this 135-month cycle does not conform with the record of glyph A, because at every other repetition of the cycle the half-year group starts with a 29- instead of a 30-day month. By using twice this cycle, or one of 270 months, grouped in two parts of 134 and 136 months each, in which the intercalary days occur in the first 132 months of each part in exactly the same positions as in the first 132 months of the manuscript table, an agreement with the glyph A record can be secured.

It must not be overlooked that as soon as adjustments are made, the possibilities for alternative adjustments increase. The fitting of the manuscript table into the inscriptions demonstrates that the record given in glyphs E and D may be a computed record, and is not, therefore, necessarily an observational one. I am convinced that other computed cycles can also be found which will fit the mathematical records of the Supplementary Series.

This paper is of necessity a brief review of my findings, and does not attempt to be exhaustive. The indigenous records of the Maya lunar count still contain many interesting unsolved problems.

My general conclusions at the present time are: first, the Maya lunar month began at either new or full moon, but the data available at present does not permit the exclusive use of either phase for the beginning of the Maya lunar month as a premise in deducing conclusions regarding Maya astronomy; and second, it can be demonstrated that the numbers associated with glyphs E, D, C and A of the Supplementary Series of the inscriptions may have been obtained by the use of a computed lunar calendar, and need not, therefore, be records of current contemporaneous observations.

OBITUARY

EDWARD ORTON, JR.

GENERAL EDWARD ORTON, JR., died at his home in Columbus, Ohio, on February 10. With him a most distinguished and unique career is closed. He was the founder of the first course in ceramic engineering which he established at the Ohio State University in 1894. He was a powerful and able investigator in the field of economic geology, ceramics and silicate technology, in which he was a pioneer. In 1898 Orton founded the American Ceramic Society which he served as secretary and editor for many years, and was its president as recently as 1930–31. His efforts were mainly responsible for the creation of a fruitful American literature on the subject of ceramics. He served the Ohio State University twice as dean of the College of Engineering, was active in the establishment of the Engineering Experiment Station, and in 1916 was elected one of the university's two first research professors. He was state geologist of Ohio from 1899 to 1906, during which time he placed the Ohio Survey on a firm basis and published a series of monographs. General Orton created the Orton Geology Library at the Ohio State University in memory of his father. He left the university when America entered the war, and despite his age, he had gone to the Plattsburg training camp. He was subsequently commissioned a major and later a colonel. His work in the Motor Transport Division was of such an outstanding character that Congress awarded him the Distinguished Service Medal. He was later made a brigadier general in the reserve corps. General Orton received many honors. He was given the honorary D.Sc. degree by Rutgers University in 1922 and the LL.D. degree by Alfred University in 1931. He was a fellow of the Geological Society, the American Association for the Advancement of Science, the American Ceramic Society, and an honorary member of the Ceramic Society of England.

Edward Orton was born at Chester, New York, in 1863 and was brought to Ohio in 1865. His father was the eminent geologist, Dr. Edward Orton, Sr., the first president of the Ohio State University.

The life of young Edward Orton was thus intimately connected with the growth of the university to which he gave his lifelong devotion. He was graduated in 1884, in the course of mining engineering and metallurgy. He was equally attached to the city of Columbus, which he served in many capacities, in the field of civics and in the cause of its charities. For two terms he was president of the chamber of commerce. He was known as Columbus' First Citizen.

General Orton leaves his widow, Mrs. Althea Orton; two sisters, Mrs. Oliver P. Watts, of Madison, Wisconsin; Mrs. Francis C. Caldwell, of Columbus, and a brother, Dr. Samuel T. Orton, of New York City.

Dr. Orton was an extraordinary man. He combined the ability of the scientist with that of the executive, and he showed rare skill in anything he undertook. He was passionately devoted to science and most humble in its service. He was, by nature, a lover of mankind, an American gentleman of the highest type, a lover of truth and justice, a broad thinker, an altruist, a striver after the beautiful. He was a man who singularly combined the qualities of strength and great personal kindness and charm. Dr. Orton's influence upon his students and associates was a powerful one and he invariably gained the respect and affection of all with whom he came in contact.

His departure is a sore loss not only to his family but to his university, his city, his state, the nation, the American Ceramic Society with the industries it represents, and to all who have felt his benign presence.

A. V. BLEININGER

RECENT DEATHS

FREDERICK LANE HUTCHINSON, national secretary and executive manager of the American Institute of Electrical Engineers, died on February 26 at the age of sixty-six years.

DR. WILLY MEYER, emeritus professor in the New York Post-Graduate Medical School and Hospital, died on February 24 while attending a meeting of the New York Surgical Society, where he had made an address on "Special Aspects of Cancer and Its Treatment." He was seventy-three years old.

DR. CHARLOTTE ANGUS SCOTT, professor of mathematics at Bryn Mawr College from 1885 to 1917, who had been living at Cambridge, England, since her retirement, died on November 8 at the age of seventy-three years.

HOWARD E. BOARDMAN, Dudley professor of railway engineering at Yale University, died on February 28 at the age of fifty-two years.

HUGH GIBB, chief preparator in vertebrate paleontology at Yale Peabody Museum, with which he had been connected for fifty years, died on February 28, at the age of seventy-two years.

PROFESSOR J. FIDEL TRISTAN, director of the National Museum at San Jose, Costa Rica, died on January 23.

SIR WILLIAM SOMERVILLE, professor emeritus of rural economy at the University of Oxford, died on February 18 at the age of seventy-one years.

SIR ARTHUR DUCKHAM, president-elect of the Federation of British Industries and a founder of the British Institution of Chemical Engineers, died on February 14 at the age of fifty-one years.

PROFESSOR R. STENHOUSE WILLIAMS, first director of the British National Institute for Research in Dairying, and research professor in dairy bacteriology in the University of Reading, died on February 2, aged sixty years.

PROFESSOR WILLIAM BILLINGTON, professor of surgery in the University of Birmingham, has died at the age of fifty-six years.

PROFESSOR ERNEST WILSON, emeritus professor of electrical engineering at King's College, London, since 1930, died on February 17.

SIR FREDERICK WILLIAM ANDREWES, emeritus professor of pathology at the University of London, died on February 24, at the age of seventy-two years.

GUILLAUME BIGOURDAN, formerly director of the Paris Observatory, died on February 29 at the age of eighty-one years. He was a member of the French Academy of Sciences and had served as president of the Bureau of Longitudes.

THE death is announced at the age of fifty-three years of Dr. Benjamin Lipschütz, professor of dermatology and syphilology at the University of Vienna.

A CORRESPONDENT writes: Dr. Ferdinand Canu, paleontologist of Versailles, France, died suddenly February 12, 1932, of cerebral hemorrhage. Born December 10, 1863, at Paris and educated there he was instructor in mathematics and sciences in the Paris schools until his retirement in 1914. His first scientific work was a text-book on meteorology, which was followed by an atlas of fifty plates on paleogeography, the first ever published. Paleontological studies then claimed his attention, resulting in many important papers, especially upon Mesozoic Bryozoa. In 1912 began the joint studies with Dr. R. S. Bassler, of the Smithsonian Institution, which have continued to date and have resulted in various monographs upon fossil and recent Bryozoa. Dr. Canu was the recipient of the Elliott Medal of the National Academy of Sciences for his quarto volumes on "The Tertiary Bryozoa of North America."

SCIENTIFIC EVENTS

ANTI-VIVISECTION ACTIVITY

THE committee of the American Psychological Association on Precautions in Animal Experimentation, consisting of Drs. C. J. Warden, E. G. Wever and W. T. Heron, *chairman*, has addressed the following letter to members of the association:

> There has been introduced to the Senate of the Congress of the United States, Senate Bill 2146, dated December 17, 1931, which reads as follows:
>
> > Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this Act it shall be a misdemeanor for any person to experiment or operate in any manner whatsoever upon any living dog, for any purpose other than the healing or curing of said dog, in the District of Columbia.
> >
> > Sec. 2. That any person convicted of a violation of this Act shall be sentenced to pay a fine of not less than $100 nor more than $500, or to undergo imprisonment for a term of not less than three months nor more than one year, or both such fine and imprisonment.
> >
> > Sec. 3. That all Acts or parts of Acts inconsistent herewith are hereby repealed.
>
> This bill is most drastic since it is leveled against *all* experimentation, not only operative work. Should the organizations backing the bill be successful in Congress, their efforts to force similar bills through the various state legislatures would be greatly facilitated.
>
> A similar bill, H-261, has been introduced in the legislature of New York State, and another bill, S-132, was introduced in the legislature of Massachusetts on January 18, 1932. Efforts toward legislation of this sort are on the increase and are backed by powerful organizations. These attempts at making laws to restrict scientific investigation should be combatted by every member of the American Psychological Association. On the other hand, these attempts to make laws to restrict scientific investigation should be a further warning to every person who conducts or directs experiments upon animals. Every precaution must be taken in the conduct of experiments to see that there can be no possible justification for the arguments used in support of these restrictive measures.
>
> It is hoped that each member of the American Psychological Association will voice his protest against the passage of the bill before Congress by writing to his respective senators and representatives. Similar action should be taken with reference to state legislators by those members living in states where bills of this nature are under consideration.

THE AMERICAN SCHOOL OF PREHISTORIC RESEARCH

THE twelfth annual summer term of the American School of Prehistoric Research will open in Berlin on July 1 and close at Starcevo, near Belgrade, Yugoslavia, on August 31. July will be spent in a study of museum collections and excursions to prehistoric sites, including experience in digging at Neolithic and Eneolithic stations in Hungary. The month of August the students will dig at Starcevo, where Neolithic, Bronze and Hallstatt cultures are all represented. The summer term will be in charge of Dr. V. J. Fewkes, assistant director of the school and director of the Harvard-American School of Prehistoric Research, Central European Expedition. The tentative program is as follows:

July 1. 10 A. M. Museum für Völkerkunde, 110 Stresemann Strasse, Berlin.
2. Berlin.
3. Silesian Museum, Breslau.
4. Breslau to Prague.
5. National Museum, Prague.
6. Hanspaulka Museum, Prague.
7. *Moravské Zemské* Museum, Brno.
8. Same.
9. Brno to Vienna; P. M., Naturhistorisches Museum.
10. Vienna; night boat for Budapest.
11. National Museum, Budapest.
12. Same.
13. Day of rest in Budapest.
14. Budapest to Tisza valley.
15–28. Excavations at Neolithic (Bükki) and Eneolithic (Tisza II) stations.
29. Arrive Belgrade; National Museum.
30. Visit Vinca and the Vasic Laboratory.
31. Leave for Starcevo.
August 1 to 31. Excavations at Starcevo.

For the last two weeks of August, students have the option of remaining at Starcevo, or of a self-conducted excursion *via* Zagreb to the Pyrenees, Dordogne and Paris.

No enrolment fee is charged to students from institutions which are supporting members of the school. Students from other institutions pay an enrolment fee of $50. The round trip ocean fare (cabin or tourist third) can be had for about $225. The cost of the two months on the continent is estimated at $300 to $350.

Preference will be given to applicants who have a knowledge of French and German and who already have at least a bachelor's degree. Graduate students may receive university credit for the course to the extent of eight hours weekly for one semester.

Applications for enrolment and requests for further information should be addressed to: Dr. George Grant MacCurdy, Director of the American School of Prehistoric Research, Peabody Museum, New Haven, Connecticut.

THE NEW YORK ASSOCIATION OF BIOLOGY TEACHERS

During the current year the New York Association of Biology Teachers has considerably expanded its activities. Started over thirty years ago in an organization meeting of twelve New York high-school teachers, it now numbers nearly six hundred. While most of its members are teachers from the forty-one senior and nearly seventy junior high schools, a considerable fraction represent university and research institutions, and an increasing number of its members work in institutions outside New York City. Its president for the current year is Mr. Paul B. Mann, chairman of the biology department at Evander Childs High School, and associate at the American Museum of Natural History.

Beginning in October, 1931, the association started the publication of a printed bulletin, *The Teaching Biologist,* under a newly appointed editorial committee. This is scheduled to appear in eight issues during the current academic year. So far, five issues have appeared, four 4-page and one 6-page. These contain abstracts of the addresses delivered before the regular monthly meetings, book reviews, brief notes on new demonstration methods, announcements, etc. Any one interested to obtain a sample copy should address Miss May-Eunice Emanuel, James Madison High School, Brooklyn, N. Y.

The association carries on a diversified series of activities. Its regular monthly evening meetings are usually attended by three to four hundred people. Working through special committees, a series of special field and institutional trips are carried out during the year. Other committees are working on equipment and pedagogy and new course syllabi. A committee of members serving as the official high school Hygiene Syllabus Committee has recently completed three new courses in hygiene, "Personal," "Home and Community" and "Personality Studies." The first two have been in print for two years; the third is now in press. Another syllabus committee has recently prepared a new syllabus for ninth-year biology which is being tried out widely in the city and state. Still another committee is working on an "advanced zoology" syllabus, and another on a revision of the "advanced biology" which is the present New York City tenth-year biology course. The new state syllabus in general biology was prepared by a committee, all the members of which are members of the New York Association.

The program committee has enlisted the following speakers for the 1931–1932 program.

October—Dr. L. T. Hopkins, "The Science Curriculum; What, How and for Whom?"

November—Dr. Henry C. Sherman, "Recent Advances in the Chemistry of Nutrition."

December—Dr. Cecil Yampolsky, "Sex Intergrades in *Mercurialis annua*"; Dr. Ralph C. Benedict, "Plant breeding, Old and New."

January—Dr. C. C. Little, "The Eugenic Viewpoint."

February—Dr. F. E. Denny, "Plant Stimulants and Hormones."

March—Dr. A. L. Kroeber, "Man as a Species."

April—Dr. M. W. Smallwood, "The History of the Reflex Action."

THE SOUTHWESTERN DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The annual meeting of the division will be held in Denver, Colorado, on April 25, 26, 27 and 28. Announcement of any paper to be read should be made to the chairman of the section concerned (see list below), and must be accompanied by a short nontechnical abstract.

Since these abstracts should be in the hands of the secretary of the division before March 15, it is urged that members submit papers to their section chairman at the earliest possible moment.

For the information and guidance of members, the following arrangements are indicated:

Section Officers

Biological Sciences: Miss Edna Johnson, University of Colorado, Boulder, *chairman.*

Physical Sciences: W. W. Lake, Box 251–A, R. F. D. 1, El Paso, Texas, *chairman.*

Social Sciences: E. E. Renaud, University of Colorado, Denver, *chairman.*

Other Organizations: F. E. E. Germann, University of Colorado, *chairman.*

Symposium: "Adjustment of Educational and Scientific Endeavor in the Light of Changed Economic Conditions." J. G. Brown, University of Arizona, Tucson.

Symposium: "Recent Advances in Science." John D. Clark, University of New Mexico, Albuquerque.

It is urged that all committees and others in charge of meetings, lunches, selection of committee members, etc., should send all program material to the division secretary not later than March 15.

COMMITTEES

Committee on Resolutions: F. J. Crider, Superior, Arizona, *chairman.*

Committee on Exhibits: C. A. Heiland, University of Denver, *chairman.*

Committee on Reception: R. E. Nyswander, University of Denver, *chairman.*

Committee on Press Service: J. H. McLennan, University of Denver, *chairman.*

Committee on Registration: R. G. Gustavson, University of Denver, *chairman.*

Committee on the Sigma Xi Dinner: M. H. Reese, University of Denver, *chairman.*

The executive committee has ruled that a registration fee of $1 shall be charged.

Further announcement concerning arrangements will be made at the earliest possible date.

M. R. SCHNECK,
Secretary

UNIVERSITY OF ARIZONA, TUCSON

THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixteenth annual meeting of the Pacific Division, American Association for the Advancement of Science, is to be held at the State College of Washington, Pullman, from June 15 to 18. The following affiliated and associated societies intend to join in the meeting through the holding of scientific sessions:

American Association of Economic Entomologists, Pacific Slope Branch. *Secretary:* H. A. Scullen, Oregon State College, Corvallis, Oregon.

American Chemical Society, Pacific Intersectional Division. *Chairman, Program Committee:* J. L. St. John, State College of Washington, Pullman.

American Meteorological Society. *Secretary:* Edward H. Bowie, U. S. Weather Bureau, San Francisco, California.

American Physical Society. *Local Secretary for the Pacific Coast:* Leonard B. Loeb, University of California.

American Phytopathological Society, Pacific Division. *Secretary:* B. A. Rudolph, Box 232, San José, California.

American Society of Ichthyologists and Herpetologists, Western Division. *Secretary:* Geo. S. Myers, Department of Zoology, Stanford University.

Astronomical Society of the Pacific. *Secretary:* C. H. Adams, 506 Merchants Exchange Building, San Francisco, California.

Botanical Society of America, Pacific Section. *Secretary:* F. DeF. Heald, State College of Washington, Pullman, Washington.

San Francisco Aquarium Society (joint meeting with Society of Ichthyologists and Herpetologists). *Secretary:* Mrs. Ethel Seale, Steinhart Aquarium, Golden Gate Park, San Francisco, California.

Society for Experimental Biology and Medicine, Pacific Coast Branch. *Secretary:* T. D. Beckwith, University of California.

Western Society of Naturalists. *Secretary:* E. G. Moberg, The Scripps Institution of Oceanography, La Jolla, California.

Western Society of Soil Science. *Secretary:* E. E. Thomas, Citrus Experiment Station, Riverside, California.

It is also hoped that a joint session of the Society of American Foresters, California, and North Pacific sections, and the western group of ecologists may be arranged. The Pacific Northwest section of the American Association of Cereal Chemists (J. L. St. John, State College of Washington, chairman of the program committee) is also expected to meet at Pullman during the third week of June.

Information concerning the presentation of papers or of other matters pertaining to the programs of the participating societies may be obtained from the secretaries mentioned above or from J. Murray Luck, secretary of the Pacific Division, American Association for the Advancement of Science, Stanford University, California. Correspondence regarding guest accommodation and matters of local arrangement should be addressed to W. E. Bradt, Department of Chemistry, State College of Washington, Pullman, chairman of the local committee.

SCIENTIFIC NOTES AND NEWS

DR. THEOBALD SMITH, who recently retired as director of the department of animal pathology of the Rockefeller Institute for Medical Research at Princeton, has been elected a corresponding member of the Paris Academy of Sciences.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry at Yale University, is honored in the March issue of the *Yale Journal of Biology and Medicine,* which is dedicated to him. This issue is called "The Mendel Anniversary Number" in recognition of the sixtieth anniversary of his birth, and contains eighteen papers written by leading scientific men. The *Journal* has as a frontispiece the portrait of Professor Mendel executed by John Quincy Adams and presented to him by four hundred former students and associates on his sixtieth birthday.

DR. WARREN WEAVER, professor of mathematics at the University of Wisconsin, was on February 1 appointed director for the natural sciences in the Rockefeller Foundation and in the General Education

Board. He succeeds Dr. Herman Augustus Spoehr, who has resumed work with the Carnegie Institution of Washington.

Dr. Albert Einstein, who has been visiting professor at the California Institute of Technology, sailed from San Francisco for Germany on March 4.

Dr. Sven Hedin, who has been visiting the United States, sailed for China on March 3.

Sir F. Gowland Hopkins, Sir William Dunn professor of biochemistry at the University of Cambridge, has been granted leave of absence with stipend for such one term as the general board may approve in each academic year in which he holds the office of president of the Royal Society.

At a recent meeting of the Royal Astronomical Society, Dr. H. Knox-Shaw, Radcliffe observer, Oxford, was reelected president. New members of the council elected are Mr. C. R. Davidson, Sir Arthur Eddington, Mr. John Evershed and Dr. R. Stoneley.

Dr. E. A. Holbrook, dean of the School of Engineering and Mines, University of Pittsburgh, has been elected president of the Coal Mining Institute of America.

Dr. Georg Geyer, emeritus director of the Austrian Geological Survey at Vienna, celebrated his seventy-fifth birthday on February 20.

Dr. Adolf Schmidt, formerly director of the Meteorological-Magnetic Observatory at Potsdam, will celebrate the fiftieth anniversary of his doctorate on March 20.

Dr. Albert Hassall, senior zoologist and assistant chief of the zoological division of the Bureau of Animal Industry, who has been in the bureau for forty-four years, was honored recently by a gathering in Washington of fifty-five scientific workers of the department and others engaged in related technical fields. The speakers on the occasion were Dr. U. G. Houck, associate chief of the bureau; Dr. M. C. Hall, chief of the zoological division; Dr. Benjamin Schwartz, senior zoologist; Dr. N. A. Cobb, Bureau of Plant Industry; Dr. Paul Bartsch, National Museum, and Dr. W. W. Cort, the Johns Hopkins University. Dr. Hassall has specialized in the compilation of index catalogues of zoological literature descriptive of more than 50,000 animal parasites. The author catalogue is being brought up to date, and the term of service of Dr. Hassall, who has just reached his seventieth year, has been extended to enable him to continue this work.

The *Journal* of the American Medical Association reports the retirement of Dr. Albert Allemann at the end of February from active duty in the library of the surgeon general's office, where he has been since 1900. Dr. Allemann was born in Switzerland in 1860 and came to the United States in 1884. He entered the library in 1900 and began the study of medicine, graduating from George Washington University School of Medicine in 1904. Dr. Allemann was for fifteen years principal assistant librarian and editor of the "Index Catalogue." At one time he was assistant editor of the "Index Medicus" and later was on the staff of the "Quarterly Cumulative Index Medicus." Testimonials of the esteem and affection of his fellow workers at the library were presented to Dr. Allemann at the time of his retirement.

Dr. Willard Rouse Jillson, director and state geologist of the Kentucky Geological Survey since 1918, resigned on February 15. During his administration 230 county and regional maps, principally in standard colors and at the scale of one inch to the mile, covering the entire commonwealth, were surveyed and published, 51 full and fractional U. S. Geological Survey topographical sheets, scale 1 : 62,500, and three new colored geological, geographic and relief maps of Kentucky, scale 1 : 500,000. During this time there were prepared and published 47 cloth-bound volumes and 27 pamphlets on the geology and mineral resources of Kentucky.

Mr. Donald Scott has been elected director of the Peabody Museum, Harvard University, to succeed Dr. Edward Reynolds. Mr. Scott has been assistant director of the Peabody Museum since 1929.

Dr. George Samuel Bond, formerly of the Johns Hopkins University School of Medicine, has been named head of the newly organized department of cardiology at the Indiana University School of Medicine at Indianapolis.

Mr. Don S. Anderson, of the division of agricultural economics at the University of Minnesota, has been appointed a member of the staff of agricultural economics at the Wisconsin College of Agriculture, the appointment to become effective on March 29.

Dr. G. F. J. Temple has been appointed to the chair of mathematics at King's College, London.

Dr. George Pacher Berry, who has been associated with the Rockefeller Institute for Medical Research, has resigned to become professor of bacteriology and assistant professor of medicine in the medical school of the University of Rochester.

Dr. Livingston Farrand, president of Cornell University, has been appointed a member of the Public Health Council of New York State by Governor Roosevelt, to succeed Dr. Jacob Goldberg, whose term of office has expired.

Dr. Alexander Silverman, head of the chemistry department at the University of Pittsburgh, has been appointed a trustee of the American Ceramic Society.

Mr. Chester Rhines, a graduate of North Dakota Agricultural College, has been appointed by the committee on the microbiology of the soil of the National Research Council to carry on investigations on the relation of amoeboid organisms to the development and persistence of acid fast bacteria in the soil, at the department of soil microbiology of the New Jersey Agricultural Experiment Station.

The title of fellow of University College, London, has been conferred on Mr. Sidney George Brown, inventor of the Brown Gyro Compass and of the Frenophone; Dr. Harold John Channon, Johnston professor of biochemistry in the University of Liverpool, late biochemist on the staff of the department of experimental pathology and cancer research in the University of Leeds; Professor Henry Albert Harris, professor of clinical anatomy at University College and University College Hospital Medical School, Hunterian professor of the Royal College of Surgeons; Professor John Turner Macgregor-Morris, professor of electrical engineering at the East London College; Dr. Egon Sharpe Pearson, senior lecturer in the department of applied statistics and eugenics, University College, London; Professor Archibald Read Richardson, professor of mathematics in the University College of Swansea, late assistant professor of mathematics in the Imperial College of Science and Technology, and on Mr. Herbert Tilley, lately surgeon to the Ear, Nose and Throat Department of University College Hospital.

Grants made by the Committee on Scientific Research of the American Medical Association include: $1,000 to Dr. Ernest Carroll Faust, professor of parasitology in the Tulane Medical School, for a study of Strongyloides infections in man and other mammalian hosts; $650 to Dr. Wm. D. McNally, for a study of the effects of tobacco tar upon the lungs of rats and other animals; $400 to Dr. William C. Langston and Dr. Paul L. Day, of the School of Medicine, University of Arkansas, at Little Rock, for further investigations in vitamin G deficiency with particular reference to cataract, the monkey being the experimental animal; $500 to Dr. Israel S. Kleiner, professor of physiological chemistry at the New York Homeopathic Medical College and Flower Hospital, for the investigation of enzymes; $400 to Dr. Clinton H. Thienes, professor of pharmacology at the University of Southern California School of Medicine, for the continuation of his work on the intrinsic nervous system of the intestine; $250 to the departments of medicine and surgery, College of Medicine, University of Cincinnati, toward a study of temperature variations in different parts of the skin; an additional grant of $250 in order to continue an investigation of the problem of carbo-hydrate metabolism and cancer growth; $250 to Dr. M. S. Burman, of New York City, for the study of fluorescent phenomena in cartilage, and $200 to Dr. Nicholas A. Michels, of the Daniel Baugh Institute of Anatomy of the Jefferson Medical College, for work on erythropoiesis. Grants were also made to Dr. E. A. Smith, of the department of zoology at the Iowa State College, for a study of the effects of certain gases on the animal body, and to Dr. H. E. Himwich, of Yale University, for an investigation of the effects of alcohol on metabolism, and for the study of the regulation of metabolism by the autonomic nervous system.

Dr. Warren Weaver, professor of mathematics; F. P. Woy, professor of engineering administration, and Dr. Gordon Ritchie, assistant professor of pathology, have been granted leave of absence from the University of Wisconsin, not from the University of Michigan, as was erroneously reported in Science.

Mr. Frank H. H. Roberts, Jr., archeologist at the Bureau of American Ethnology, has been detailed to the Carnegie Institution of Washington to serve as consulting archeologist for excavations at Chichen Itza.

Dr. J. Enrique Zanetti, professor of chemistry at Columbia University, will represent the Chemical Foundation of New York and synthetic nitrate interests in the United States in a survey of the Chilean Nitrate Industry.

Dr. J. Paul Visscher, head of the department of biology of Western Reserve University, left for Europe on March 8 to continue his work on barnacles. He plans to work at Naples until May and later at Plymouth.

Mr. Carl O. Erlanson and Dr. Howard MacMillan are members of an American research mission to Peru, whose principal object is the study and collection of fly pests which are attacking fruit-bearing shrubs and trees.

Dr. C. B. Williams, lecturer in entomology at the University of Edinburgh, has been appointed professor of entomology at the University of Minnesota for the spring quarter. During that time he will give a series of lectures in advanced economic entomology. At the termination of this appointment Dr. Williams will return to England to become chief of the department of entomology at the Rothamsted Experimental Station.

Professor L. J. Henderson, of Harvard University, gave a public lecture on "The Influence of Galileo on Medical Science" on March 8.

DR. LESLIE T. WEBSTER, of the Rockefeller Institute, will deliver the sixth Harvey Society Lecture at the New York Academy of Medicine, on Thursday, March 17, on "Experimental Epidemiology."

DR. LEWELLYS BARKER, of the Johns Hopkins University, delivered the annual Alpha Omega Alpha Lecture at the Jefferson Medical College, Philadelphia, on Friday evening, March 4, on "Medical and Other Conditions in Soviet Russia."

THE Minnesota chapter of Sigma Xi recently sponsored the following series of lectures on "Evolution and Civilization": "Critical Epochs in Plant Evolution," Dean E. M. Freeman; "Physical Development of Man," Dean R. E. Scammon; "Primitive Men and Their Cultures," Professor A. E. Jenks, and "Evolution and Life Values," Professor David F. Swenson. The lectures were held in the Northrop Memorial Auditorium on the campus and were open to the public. The attendance was as large as forty-five hundred.

DURING the week of February 8, Dr. Carroll Lane Fenton gave four illustrated lectures before the Department of Geology at the Massachusetts Institute of Technology. His subjects were: "The Environment and its Records"; "Animal Associations of the Sea," "Natural History of Fossils" and "Theories and Records of Evolution."

AT the University of Glasgow, Sir Arthur Keith delivered the Fraser Lecture in anthropology on March 4.

THE American Association of Pathologists and Bacteriologists will meet in Philadelphia from April 28 to 29, instead of from March 24 to 25.

THE Seventeenth Congress of the German Dermatological Society will be held in Vienna from May 16 to 18, when the principal subject for discussion will be cancer of the skin, introduced by Lubarsch of Berlin and Miescher of Zürich.

AN Associated Press dispatch reports that preservation of approximately 6,000 acres of redwood forests in northern California has been made possible by a gift of $500,000 by Mr. Edward S. Harkness, of New York. The contribution has been matched in part by funds from the California State Park Commission and a deed to the forest lands has been acquired by the commission.

THE enlargement of the Bandelier National Monument in New Mexico to approximately 30,000 acres, to give additional protection to its unique prehistoric Indian ruins, and the transfer of jurisdiction over the area from the Forest Service to the National Park Service by presidential proclamation was recently announced.

DISCUSSION

DIRECT FINANCING FOR BASIC SCIENTIFIC RESEARCH

IT is a familiar lament that no part of the financial profit returns directly to science in many cases where scientific research results in applications of great monetary value. Professional tradition forbids the scientist to patent his findings for personal gain, and scientists as a group have been slow to take financial advantage of new knowledge that might be used in support of investigation. There are, however, signs of a changing attitude. In recent years there have been a number of cases in which patents have been taken by individuals or institutions either to protect the public from extortion, in a medical product like insulin, or to secure funds for future investigation. A number of universities derive revenue for research from such royalties, and a corporation has been organized by American psychologists with this as one of its major purposes. The dictum that a scientific laboratory might "live by its findings" appeals to many as sound. If the initial findings were of sufficient practical value a laboratory might even become endowed by a single discovery.

The latest conspicuous example of this movement on the part of American scientists is the current financing of the Basic Science Research Laboratory of the University of Cincinnati. As first conceived by President Schneider, who was then dean of Engineering, this laboratory was to be a cooperative undertaking designed for a physico-chemical approach to biological problems by individuals trained in different fields. It was further hoped that results of commercial value might be obtained and thus financial independence be secured. As the annual budget that could be provided by the school of engineering was a modest one, it was necessary at the outset to undertake certain "commercial" research, and as there was no other housing available the work began literally in a garret. But those who visited that garret in its early years were impressed and not so greatly surprised when the youthful enthusiasm and the downright ability of its investigators brought forth results of scientific importance and commercial value.

With President Schneider as the presiding genius, who conceived the plan and gave it backing in the face of discouragement, and with Professor Sperti as the leader in the laboratory, results have been obtained that have exceeded expectations. The group of investigators that is being developed at Cincinnati can now proceed with adequate financial support of their own making and may hope that other facts of commercial as well as theoretical importance will be discovered in the future. If once established on a sufficient scale, such a laboratory could maintain not only workers in pure science but also individuals with a sense for the profitable utilization of scientific findings in ways that would probably be overlooked by the investigators themselves.

Briefly, the findings at Cincinnati aside from their theoretical importance have such commercial possibilities that the patents granted have been sold for an amount sufficient to build a laboratory and operate it for several years, while the royalties expected in addition to this fixed payment should be sufficient for the indefinite operation of the undertaking. After a study of the practices in other institutions that support investigation by such means a plan was devised that merits consideration by any university so fortunate as to command revenues of this nature. The essentials of this plan include:

(1) Payment of a cash sum to the university. This money will be used in various ways to further basic research.

(2) Formation of a holding company in which the corporation that has contracted for the patents owns a majority of the stock but the University of Cincinnati a good minority. The university has two members on the board of directors of this holding company, and the corporation involved has three members.

(3) Agreement that the name of the university can not be used in advertising, except with the consent of both university members of the board in each case; that the university will not be involved in the commercial part of the work, except as it is represented on the board of the holding company by the two members; that all developmental research shall be done by the holding company; and that the university shall retain all rights as to medical discoveries and shall derive no financial profit from such discoveries.

(4) There are a number of other provisions, including the control of advertising, stock sales, licensing, etc., all with a view to protection of the public as well as the good name of the university.

Under this form of organization the royalties are received by the university as dividends on its stock in the holding company. The patents are taken out by the workers in the laboratory, and then turned over to the university with the proviso that all the receipts go into scientific research, until this part of the university's function is adequately met. Any remaining funds may go to the general funds of the university, after certain other needs related to research have been provided.

Foremost among the studies that have resulted in this financial provision for future research is the work of Professor Sperti and his associates in the field of ultra-violet radiations. Germicidal and other effects of these rays occur, in many instances if not universally, at critical wave-lengths. It is possible by means of filters to use the radiations for one effect and to block out another effect if the critical points are not too close together. For example, an enzyme had been developed for use in bread-making. As commercially prepared, it produced a bread that decomposed within a short time after baking because moulds and bacteria found their way into the enzyme mixture as manufactured. To have sterilized by heat would have destroyed the enzyme, and to introduce an antiseptic strong enough to be effective was impossible in a product destined for food. The findings at Cincinnati had shown that many enzymes were inactivated at a critical wave-length far enough removed from the wave-length at which bacteria were destroyed so that proper filtration gave destruction of the bacteria without injury to the enzyme. The mixture as thus sterilized produces large loaves of fine texture which can be kept in good condition for long periods. There are so many other applications that one of the largest corporations in the country has become a party to the agreement described in preceding paragraphs of this article. By this means the laboratory in which these facts were established should obtain funds for its continued and independent existence.

If an increasing number of research laboratories can thus be established and "live by their findings," such a development will be one of social as well as scientific importance. Great corporations maintain research laboratories, because in the long run both laboratory and corporation live by new discoveries or by more precise applications of old ones as determined by research. In the situation proposed, workers in pure science would themselves develop industrial applications in order that basic research might obtain adequate financial support and thus live by its findings. If self-maintaining relationships like the one just initiated at the University of Cincinnati could be widely established under the control of scientists, the method would be superior to the existing condition by which basic research is supported inadequately and in haphazard fashion through private philanthropy or as a "noble charity" by industrial organizations.

W. C. CURTIS

UNIVERSITY OF MISSOURI

THE SUPERVISION OF STUDENT RESEARCH

THE practice of having the student who is engaged in experimental research submit weekly written reports of progress has so many advantages that one wonders why it has not come into more general use. Because research is usually costly, there exists the pernicious, and false, idea that it must be inefficient *per se* and that an almost wanton extravagance in the use of time and of materials may be justified, or even necessary, for the accomplishment of results. There are many who know, however, that it is quite possible to teach the beginner in research how to be economical with his time and materials and how to work systematically and speedily toward definite objectives, so that he may obtain, in the most efficient manner, the best results that his abilities will permit. By this, I do not mean to imply that research can be reduced entirely to formulas, any more than can any other kind of creative work.

It is my experience that the written progress-report, when used as a complement to the personal conference, is a most effective means of promoting such efficiency. The student must of course be made to see very clearly that these reports are only a means toward an end in his research and that they are not, for example, intended to be a check on the number of hours that he spends each week on his work. Their purpose is to encourage systematic planning of work and frequent estimates of progress and to afford the student the opportunity of laying his case, so to speak, before the director of his research at least once every week. There is a great advantage in having the student begin to make his reports as soon as he has selected his problem; these initial reports, which must necessarily deal mostly with the preparatory reading, provide definite objectives toward which he can work from the very start, something which the beginner often lacks in the early stages of his problem.

The form of report that follows has proved itself suitable for experimental physics; the numerals in parentheses indicate the number of blank spaces allowed for each item:

Weekly Report of Research Progress

Name .... Date ....

General problem: ....

1. Particular work in which now engaged: (4)
2. Progress during the past week: (8)
3. Specific difficulties encountered: (10)
4. Approximate date of completion of this particular work: (2)
5. Next specific project probably to be undertaken: (6)
6. Unavailable apparatus and supplies needed for this new work: (8)
7. Bibliography of the week,
    (a) Publications found: (8)
    (b) Publications read: (*Use reverse side for titles and for points involved in these papers which need discussion in conference.*)

The reasons for including these various items in the report are too obvious to require much comment. The fifth item is perhaps the most important of all. The usefulness of the sixth will be apparent to any one who has experienced the aggravating delay involved in obtaining equipment that is not already in stock. The last two items serve as weekly reminders to the student to be constantly on the watch for new papers having a bearing on his problem and to read continually. In this connection, it is worthy of remark that a certain foreign-trained physicist whose opinion is to be respected and who has a high regard for the state of experimental physics in this country deplores the waste of time and money which results from the failure of many American-trained physicists to study thoroughly the literature dealing with their problems.

It must be emphasized that these written reports are not intended to supplant the personal conferences which the supervisor must have with his students. In a sense, they are to be regarded as a preparation for the conferences. Through the medium of the report the supervisor has advance knowledge of the specific difficulties confronting the student, and it sometimes happens that the student himself will arrive at a solution of these difficulties, simply because the written report has forced him to define and clarify them.

If there is a single disadvantage in using such a system of reports it has not yet become apparent. Seven students are at present using this method under my direction; four of them are graduate students working independently, two are graduate students working as apprentices to more experienced students, and one is an undergraduate. All of them have reacted favorably to the plan and have recognized its advantages. The research supervisor who has not as yet used this or a similar method would do well to consider it, especially if he is attempting to direct the research of several students while engaged in other teaching and in his own research.

DUANE ROLLER

DEPARTMENT OF PHYSICS,
UNIVERSITY OF OKLAHOMA

VITAMIN A AND THE IODIN-FAT BALANCE[1]

So many papers have been published within the past two years regarding the rôle of carotene as a precursor of Vitamin A that it may not be out of place to call attention to the fact that carotene is a highly unsaturated hydrocarbon ($C_{40}H_{56}$), and that it is commonly administered in combination with arachis (peanut) oil which has an iodin value ranging from 83.0 to 100.0 and which contains the unsaturated linoleic and oleic acids, together with several of the saturated acids. While the manner in which carotene may behave has not been clearly demonstrated, it is the belief of the writer that its significance in the formation of Vitamin A in the animal depends in large part upon:

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[1] From the Laboratories of West Virginia University, Morgantown, West Virginia. Aided by a grant from the National Research Council.

(a) The rôle of the unsaturated hydrocarbon carotene and the associated fatty acids found in arachis oil in restoring the fat-iodin balance in animals, fat depleted by Vitamin A deficiency diet.

(b) Its action in restoring the desaturating power of the liver.

From a series of studies with ferrous iodide carried on since 1925 we have come to the conclusion that there are two factors in recovery from Vitamin A deficiency, one, effective in curing *xerophthalmia,* and *otitis media,* and in awakening the dormant thyroid; the other belonging to unsaturated fats and hydrocarbons, aiding to restore the iodin-fat balance and facilitating growth.

As reported at the Cleveland meetings of the American Association for the Advancement of Science (1930) we find that linoleic acid is extremely effective when combined with the ferrous iodide. Studies during the past winter and now in progress indicate that ferrous iodide and linoleic acid will act more favorably on rats, profoundly depleted of Vitamin A, than cod liver oil.

That ferrous iodide alone should prove beneficial in Vitamin A deficiency, accompanied by certain symptoms of thyroid disturbance is probably due to the iodin action on keratinized tissues and the withdrawal of stored fats from the animal. The dormant thyroids of animals that have received a fat-free diet for some time are apparently stimulated by the ferrous iodide, and the addition of unsaturated fats aids in restoring the balance. Further details regarding the experiments now in progress will be published soon, with the names of our laboratory assistants (Chidester, Bourne and Wiles).

For a long time it has been known that while Vitamin E is essential for reproduction, it is no more so than Vitamin A. Evans and Burr (1925) have stressed the fact that Vitamin E is concentrated in the seeds and embryos of certain plants as well as in egg yolk. The fact that in experimental studies that we are now carrying on, we have noted gonadal development in animals thoroughly depleted of Vitamin A and then furnished linoleic acid and extremely small quantities of ferrous iodide is, we believe, rather significant. Schmidt (1891) and also Miller (1910) and Ivanow (1912) have shown that the *iodin* numbers of the *unsaturated acids* and oils of various seeds decrease during germination. Numerous investigators have demonstrated that either an excess of iodin or an excess of fat will induce sterility in experimental animals. We contend that iodin-fat imbalance is a most fundamental one in deficiencies in fat soluble Vitamins A and E.

F. E. CHIDESTER

THE FEEDING HABITS OF THE FIRST INSTAR LARVAE OF THE CLUSTER FLY

FIRST instar larvae of the cluster fly, *Pollenia rudis* (Fab.), have been observed in the laboratory feeding upon the earthworm *Allolobophora caliginosa* (Sav.). Former records indicate only *Allolobophora chlorotica* (Sav.) and *Eisenia rosea* (Sav.) as hosts to this parasite.

Former investigators have not observed the entrance of the first instar larvae into the body of the earthworm. Keilin (1915) suggested that the larvae probably enter by means of the genital pores while the worms are in copula.

First instar larvae have now been observed by the author to enter directly through the cuticula. They have been observed in various stages of entrance, from the time when only the mouth parts were imbedded in the cuticula until only the posterior spiracles were exposed. First instar larvae apparently always feed with the spiracles exposed.

As many as five larvae have been observed feeding on one worm. They usually enter the anterior portion of the worm in the region from the tenth segment to a few segments posterior to the clitellum. All the larvae so far observed have entered the worm from the dorsal side. While the usual place of entrance seems to be the intersegmental furrows, the larvae have been observed entering through the thicker portions of a segment and also through the clitellum.

The earthworms were placed in a petri dish containing usually about thirty eggs of the dipterous parasite. The worms were introduced as the larvae began to emerge from the eggs. Parasitism usually occurred about two days later.

Mrs. Grace Pickford Hutchinson, of Osborn Zoological Laboratory, Yale University, very kindly identified the earthworms as *A. caliginosa* (Sav.).

R. M. DECOURSEY

DEPARTMENT OF ZOOLOGY,
CONNECTICUT AGRICULTURAL COLLEGE

BRANCHINECTA COLORADENSIS IN COLORADO

IN the February 27 and September 11, 1931, issues of SCIENCE there was a discussion as to means of dispersal of the fairy shrimp, *Branchinecta coloradensis.* In the latter article it is also recorded from a hollow in a boulder at the elevation of 8,000 feet near Estes Park. In Ward and Whipple it is recorded as an alpine species. Dodds, in his "A Key to the Entomostraca of Colorado," gives its distribution as alpine, but with one record from St. Vrain at an elevation of 5,100 feet.

My own experience shows that it is not nearly so strictly alpine as has been supposed. I have collected it from small hollows in granite outcroppings on Arthur's Rock, west of Fort Collins, and overlooking the plains, elevation about 6,800 feet; about four miles east of Allen's Park, elevation about 8,300 feet; and on Old Man Mountain, just west of Estes Park village, elevation 8,300 feet. In these little hollows it was often quite abundant, but smaller than individuals from the alpine ponds. This might well have been due to the lack of food in these temporary puddles. I have also found it in the ponds of the thick timber around the 10,000 feet levels.

I have assumed in the past that wind was a considerable factor in distribution. The eggs undergo desiccation and might then be carried by the wind. The hollows were on exposed outcrops. The winds of the winter half of the year are often quite strong, and prevailingly from the west or northwest, so that the eggs could conceivably be carried out over the middle and lower mountains, and dropped in the small hollows which are characteristic features of the rock ridges and outcrops.

KENNETH GORDON

UNIVERSITY CAMP,
UNIVERSITY OF COLORADO

A TEMPORARY RESPITE FOR THE WHALE

THE past season's whaling operations resulted in a killing orgy, chiefly in the Antarctic, that broke all records. The world catch, of late increasing from season to season, amounted last year to 38,563 whales, which yielded more than 3,427,000 barrels of oil. The supply so far exceeded all ordinary demands that whaling vessels were laid up and much oil stored. Present-day whaling is largely a Norwegian industry, about which there is not much general knowledge in this country. Naturalists concerned about the supply of whales have been wondering what the next move of the industry, with its huge investment in specially built steamships, would be.

Information received last week from a Norwegian friend in Tonsberg, who knows what is going on, throws light on the subject:

> . . . So far as I can gather, the outlook is this: Next season only the modern vessels will go out, and that only provided they have been able to sell the oil in advance. There is still a quantity of say 500,000 barrels unsold of last season's catch. . . . Sandefjord, Tonsberg and Larvik are the New Bedford, New London and Nantucket of Norway at the present day, with Sandefjord leading. I visited that place the other day, and I must confess that the harbour was a truly magnificent sight; whale catchers in long rows, one alongside the other, and the huge factory ships completing the picture. Some 8,000 men are idle at home this year. . . .

My correspondent adds that only two fleets, those of Leith and Liverpool, comprising four factory steamers with their complete sets of whale catchers, have been sent out. Early last summer I boarded one of the big Antarctic whalers, unloading her oil —55,000 barrels—at Staten Island. She had taken 1,445 whales.

The species chiefly pursued in Antarctic waters are blue whale and finback, which did not figure in the catch of the old time whaler. His methods were less effective. Other kinds of whales, such as sperm, right, humpback and sei, are no longer abundant. These were greatly reduced in numbers during the nineteenth century. The grey whale has become a rarity and the once important bowhead does not figure in modern whaling at all.

There is a year's supply of whale oil on hand. Whaling ventures as a whole are in abeyance until next fall. It is evident that the stock of whales has greatly decreased. It would be deplorable if the last season's slaughter were repeated in 1933, and the world's most important animal-oil resource seriously damaged.

C. H. TOWNSEND

NEW YORK AQUARIUM,
FEBRUARY 13, 1932

EPIZOOTIOLOGY

THESE pages frequently serve as a hospital for sick words. May I therefore bespeak a bed for "epizootiology," whose usefulness appears to have passed and who may well be relieved by the more vigorous word "epidemiology"?

I am acquainted with some learned men who think it an outrage to apply this most valuable word to the spread of disease among animals, men to whom presumably the epidemiology of anthrax conveys a totally different idea from the epizootiology of that disease, but who may be puzzled to find any word for a spreading disease among insects. Surely the idea which is carried by the word "epidemic" centers on disease, and "the spread of disease" as a separate idea does not fundamentally concern the association of that disease with plants, men, animals, land, sea, Europe or America.

Where words are concerned the purists lose in the end; and in spite of what may be said to the contrary common use is often common sense. Valuable new words grow into definite meanings of their own and forget their origins, while bad words die. There can be little doubt that "epidemic" is growing into the recognized English word for disease spreading amongst any community.

A recent correspondent of SCIENCE writes that "the English language would be in better shape if some people knew less Greek and Latin," and I suggest that, if the epidemiologists will leave their experimental animals for a few moments we might take "epizootiology" from the sick bed to the lethal chamber. Their studies could then be resumed in peace, free from the disturbing thought that much of their epidemiological research is in reality epizootiology.

E. L. TAYLOR

VETERINARY LABORATORY,
MINISTRY OF AGRICULTURE AND FISHERIES,
WEYBRIDGE, SURREY

SPECIAL CORRESPONDENCE

EUROPEAN EXCURSIONS IN 1932

Two cooperative excursions through Europe are being organized for the summer of 1932, the programs of which present some unusually attractive features and the costs of which will be moderate. While intended primarily for entomologists attending the Fifth International Congress of Entomology at Paris in July, and for their families and friends, other scientific men, up to certain limits, will be welcome.

The first group will sail from New York on the *Leviathan* on June 11, visiting (among other places) Copenhagen, the Gota Canal in Sweden, which will be partly traversed on midsummer night when all the village folk hold festival and dance all night in the open air; Stockholm, Uppsala, the summer home of Linnaeus at Hammarby, and thence by rail northward to the Swedish National Park in Lapland, where a stay of some days will be made on the Arctic tundra at Abisko with views of the midnight sun. Those who wish will have time to continue by excursion steamer to the North Cape and back. Returning to the Continent, some days will be spent in Holland and Belgium before going to Paris for the congress. After that event there will be a week's excursion in the Pyrenees, arranged by the French local committee of the congress. Then Avignon will be visited, with an excursion to Orange and the home of Fabre at Serignan. Continuing to Grenoble, the party will traverse the Savoyan Alps by motor coach to Argentières at the foot of Mount Blanc, and after some days will continue by motor coach to St. Jeanne de Maurienne, and thence into Italy, where Turin, Genoa, Pisa, Naples, Rome, Assissi, Perugia, Florence, Bologna and Venice will each be visited. Continuing over the Brenner Pass, a short stay will be made on the Eibsee in the Bavarian Alps, with opportunity to ascend the Zugspitze, Germany's highest peak. Munich, and the three beautifully preserved medieval cities, Dinkelsbühl, Rothenburg and Nuremburg, will be visited, also Leipzig during the autumn fair, Dresden, the Spreewald and Berlin. After a final few days in England the party will sail for home on September 17 from Southampton.

The second group will sail from New York on the *Olympic* on July 1, joining the first group in Holland and remaining with them until the Alps are reached. They will omit Italy, and make a somewhat swifter tour of Germany, with also a few days in England before sailing on August 27, on the luxurious new liner *Manhattan*. Those wishing to go directly to the congress will sail on the *Majestic* on July 8.

These are not conducted tours in the usual sense, but are organized for pecuniary benefit of individuals comprising a group. Members will be free to follow their own inclinations at the stopping places, and in the larger cities in most cases may take their meals at restaurants of their own choosing. While many of the points to be visited were selected because of their importance as entomological centers, all will be full of interest from other points of view.

Estimates are based upon tourist class (former second class) at sea, second-class railway, unpretentious but thoroughly comfortable and clean hotels and inexpensive restaurants, with an allowance for side-trips and for incidental and personal expenses. They have been kept as low as possible, consistent with comfort, in order to make the trips available for students of limited means, who may look upon them as part of their educational equipment.

Readers of this notice, who may be going to Europe, even though not as members of one of the groups, are welcome to share in certain advantageous arrangements which the committee has been able to make, provided they request the committee to obtain their steamship reservations for them.

For complete circulars and information address the undersigned, who is chairman of the Joint Committee of the Entomological Society of America and Association of Economic Entomologists on Transportation to Europe.

O. A. JOHANNSEN

ROBERTS HALL,
ITHACA, N. Y.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MICROSCOPE FOR OBSERVATION OF FLUORESCENCE IN LIVING TISSUES

FLUORESCENCE, the phenomenon which makes possible the technique described below, has been utilized in microscopic work, but principally in relation to the study of inanimate organic compounds. It may be defined as the property possessed by certain substances to generate light which is different in color from the light thrown upon them. For example, in the path of invisible ultra-violet rays, aesculine has a brilliant blue fluorescence. There is a twofold specificity in the property, first in the length of the wave to which the substance will respond, and, second, in the color of the induced light. The fluorescence microscope has made use of this specificity to identify substances which are similar morphologically but different chemically (Lehmann, '13, Wasicky, '14, Heller, '16, Merritt, '26).[1] The study has been applied to the animal body, and fluorescence has been found to be of general occurrence, but it is very slight except in the case of certain special tissues, the lens of the eye, for example.

For this reason the characteristic, inherent fluorescences of the individual tissues could not be made the basis for observation of the living animal. Instead, a highly fluorescent and non-toxic solution, such as uranine or aesculine, was injected into the animal and as it was taken up by the blood plasma, it transformed the latter into what may be pictured as a circulating source of light. The different elements of the tissues were brought into visibility by their varying degrees of opacity to the induced light or their power to refract it, by their opacity to the incident light or by absorption of the fluorescent substance itself.

Although the ordinary fluorescence microscope employs transmitted light, this type of illumination had to be abandoned in observation of the organs or tissues of the intact animal (frog, rat, mouse, etc.) because of their opacity. Oblique illumination sufficed for primary magnifications up to 30 diameters, but for higher magnification vertical illumination was used. In the latter case, the rays of light were reflected through the objective by means of a vertical illuminator similar to the instrument used in metallurgical investigations (Fig. 1). In order to obtain a uniform illumination of the object, it was necessary to have the back lens of the objective as near to the glass plate reflector as possible (Fig. 1 D). The magnifications obtained varied from 300 to 1,200 diameters. The focusing collar (manufactured by the Bausch and Lomb Company) illustrated in Fig. 1 G, was designed to accomplish two things: (1) to hold the object at the proper place of focus, and (2) to permit the surface of the lens to be washed free of blood and débris by a perfusing fluid such as physiological salt solution. Without this device, continuous observation was almost impossible.

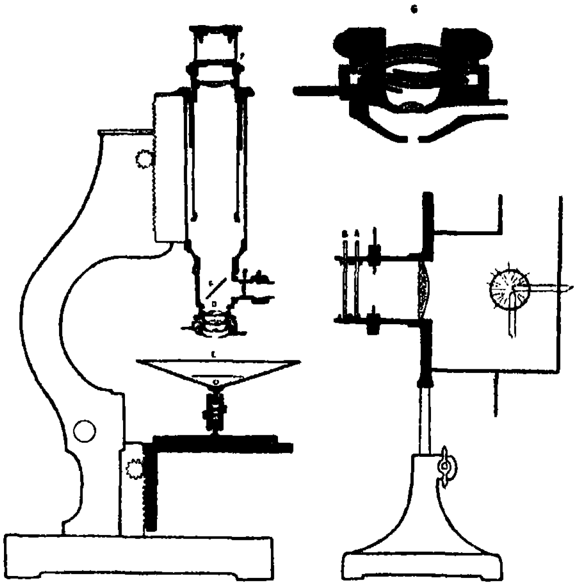

FIG. 1. The microscope and the illumination apparatus. (A) Heat-absorbing filter; (B) main absorbing filter; (C) planoparallel slide of the vertical illuminator; (D) lens with focusing apparatus; (E) adjustable operating board and mechanical stage; (F) eyepiece with complementary absorbing filter; (G) lens with focusing apparatus, original size.

The therapeutic sunshine carbon arc of the National Carbon Company was usually employed as a source of light, although any light source rich in ultra-violet, such as an iron, carbon or mercury arc, proved satisfactory. The band of spectrum reflected by the planoparallel glass slide of the vertical illuminator was controlled by selective filters. The injurious infra-red rays were eliminated by 3 mm of heat-absorbing glass (Fig. 1 A). Although this filter allowed but 64 per cent. of the radiant energy from the arc to pass, it did not make an appreciable reduction in the brightness of the light.

The main absorbing filter (Fig. 1 B) was varied to select the band of spectrum most effective for the fluorescent compound in use. The optimum conditions were obtained when rays which were not effective in inducing fluorescence were eliminated because the reflection of diffuse light by the tissues interfered with visibility. With aesculine, the Red Purple Ultra (Corning Glass Works) was used. It transmitted 365 μ ultraviolet, 405 μ violet and 435 μ blue as well as extreme red, but the latter was unimportant since it had already been eliminated by the heat filter.

It was not always possible to obtain the exact combination of wave-lengths required for a particular fluorescent substance by means of the main filter alone. When this was the case, the desired bands were added by the introduction of a supplementary light source and appropriate filters (Fig. 2_4).

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[1] R. Heller, "Fluorescence of Alkaloids and Its Application in Toxicological Investigation," *Intern. Zeitsch. phys. Chem. and Biol.*, Vol. 2, pp. 297–411; *Intern. Chemical Soc.*, Vol. 110, ii, p. 502, 1916; Lehmann, "Luminescence Microscope," *Ztschr. f. wiss. Mikr.*, Vol. 30, p. 449, 1913; Merritt, "The Form of the Absorption Bands in Solutions of Organic Dyes and a Relation between Absorption and Fluorescence," *Phys. Rev.*, Vol. 28, pp. 684–94, 1926; R. Wasicky, "The Fluorescence Microscope in Pharmacognosy," *Pharm. Post* (Vienna), Vol. 46, pp. 877–8, 1914.

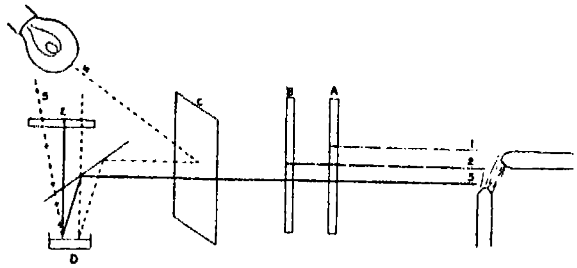

FIG. 2. The path of the rays. (1) Infra-red rays; (2) visible rays; (3) ultra-violet rays; (4) rays of the supplementary illumination; (5) fluorescent rays. (A) Heat-absorbing filter; (B) main absorbing filter; (C) reflector (Corex D Glass 2.10 mm thick); (D) tissue and fluorescence fluid; (E) complementary absorbing filter.

In order to make the outlines of the objects clearer, a complementary absorbing filter was inserted in the tube of the microscope between the eyepiece and the vertical illuminator. Different filters were required for different colored fluorescent light. With aesculine, which gives a blue light, a green filter (Nultra, Corning Glass Works) was used. Green required a yellow complementary filter, while violet fluorescence required none.

The important and difficult part of the technique deals with the light source and lens equipment. The procedure for making observations can be given briefly. Aesculine will be given as an example because it gives a brilliant fluorescence. The experimental animal (frogs, rats and mice have been used) was anesthetized and fixed to the adjustable operating board (Fig. 1 E). After the desired tissue or organ was exposed, it was brought into focus with ordinary white light. A concentrated aqueous solution of the fluorescent substance was injected subcutaneously. The filters (Figs. 1 A and B) were inserted and observation made through the microscope until fluorescence appeared.

This technique not only gives us a new application of a method (Thiel, '26, Ellinger and Hirt, '29)[2] for observing the interior of the living organism, a subject of interest in itself, but it has opened up a new experimental approach to other problems. It has given some unexpected information concerning the penetration of the layers of the skin by different wave-lengths of light. The excretion of aesculine by the liver and kidney causes the bile capillaries and uriniferous tubules to become brilliantly illuminated, and this is being used as the basis for physiological studies of these organs.

EDWARD SINGER

COLUMBIA UNIVERSITY

AN IMPROVED PROSPECTING PICK

GEOLOGISTS and fossil collectors have long felt the need of an accurately adjusted light prospecting pick, but heretofore only hand-made tools of this description have been obtainable.

After years of experience the American Museum of Natural History has developed what is considered a perfect tool of the kind, of drop-forged highest grade 85 carbon tool steel, with a perfect eye extended so as to secure the full purchase power of the handle. A metal bar inset over the head of the handle and riveted insures a perfect fit during the life of the tool regardless of shrinkage or number of times the pick is removed from the handle. Length of metal head fifteen inches, length of handle twenty-one and one half inches, total weight one pound and ten ounces.

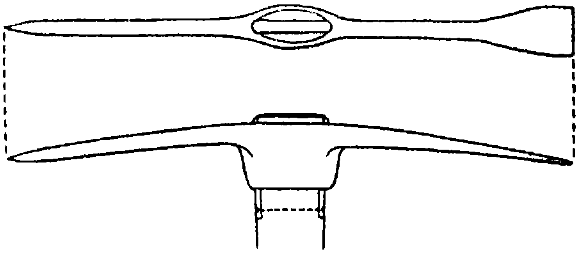

FIG. 1

These picks can be obtained from the Department of Vertebrate Paleontology, American Museum of Natural History, New York City.

BARNUM BROWN

JANUARY 26, 1932

A QUICK METHOD OF EMBEDDING SOFT MATERIAL IN CELLOIDIN

AT the suggestion of Dr. A. F. Hemenway some experiments were made with celloidin dissolved in acetone for embedding green material that requires no softening. The blocks of material were prepared for cutting in three days by ordinary laboratory methods. Under reduced pressure leaf and soft stem material of *Hedera helix* and *Olea europea* were prepared in 50 minutes from the time the fresh material was gathered until the sections were mounted in balsam on the slides. There was little or no plasmolysis, no alteration of the natural color of the material, but it was necessary to bleach with 95 per cent. alcohol when staining was desired.

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[2] Thiel, "Contribution to the Slit Lamp Microscopy of the Eye in Ultra-violet Light," *Ztschr. f. Augenheilk.*, Vol. 58, p. 56, 1926; Ellinger and Hirt, "Microscopical Observation on Living Organs," *Zschr. f. Anat. u. Entw.*, Abt. i, 90: 791–802, 1929.

Schedule:

Cut material so that vascular tissue is not more than ½ inch long.

Under reduced pressure, place in killing solution consisting of formalin, 6.5 cc; 50 per cent. alcohol, 100 cc; glacial acetic acid, 3 cc; glycerin, 5 cc.

Leave in killing solution five minutes.

Put through two changes of water, two minutes each.

Flood with acetone for five minutes, then for five minutes each in the following percentages of celloidin and acetone: 3 per cent., 7 per cent., 10 per cent., and 14 per cent.

Place specimen on wood block with a thin covering of very thick celloidin. Let it become firm in air, then drop into chloroform until solid enough to cut.

Although infiltration was not complete, 12m sections without breaks were obtained, of a quality quite satisfactory for use in elementary classes.

UNIVERSITY OF ARIZONA PALMER STOCKWELL

SPECIAL ARTICLES

TRICHROMATIC FUNCTIONS OF THE AVERAGE EYE[1]

THE trichromatic color mixture curves have been studied on 68 subjects. Inasmuch as certain of the observations are quite inconsistent with classical color theory, it has been thought best to publish them in an abbreviated form in a periodical of general scientific circulation. The detailed report is in press elsewhere.

The apparatus is a modification of the Maxwell color-box, secured against stray light and equipped with variable slits in such a fashion that one can mix lights of any wave-length and a standard white in a semicircular field, and compare such mixtures with monochromes or mixtures in another juxtaposed similar field. The total field size was 1° 40′.

The source was two 500 watt tungsten lights operated at 2790° K diffused by three double ground sheets of optical glass (Eastman).

With standard white on one field and a mixture of the three primaries, 480, 517 and 670 mμ, on the other, each of the 68 subjects was asked to glance at the field (with centered pupil) and say how the appearance differed from a perfect match. In the light of his answer the color mixture was changed until the subject stated, after looking with each eye rested, that he could see no difference between the fields.

Dichromatic matches to monochromes were made in the same fashion.

The average amounts of the primaries required to match white are red 1.740 mm of slit-width; green 1.441 mm, and blue 1.249 mm after adjustments had been made for green excitation in 480 mμ. Instead of recalculating our data to conform to assumptions of equality of chromatic valence of the three primaries, any other match is presented and plotted directly as the slit-width of each primary required for a white or found.

(1) This investigation had for its first aim the de-

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[1] From the Department of Physiology and Pharmacology and the Department of Psychology, University of Louisville, Kentucky. This investigation was aided by a grant from the American Association for the Advancement of Science.

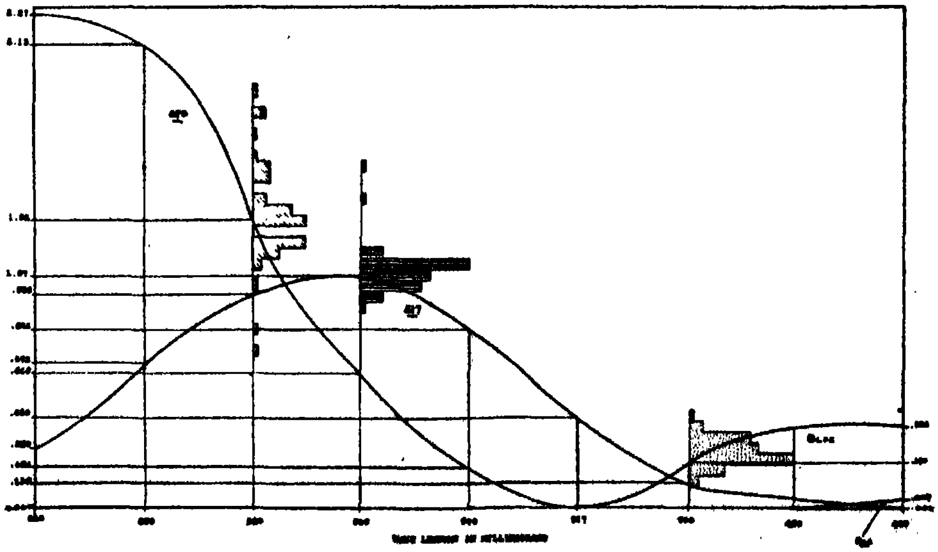

FIG. 1. Excitation Curves for Average Eye. (Showing also sample distribution of sensitivity in the population: diagonal is red; horizontal is green; stippled is blue.

termination of the sensitivity of the average eye to each of the three primaries. Normal individuals differ widely in these respects. Yet each investigator has hitherto offered results for an inadequate number of subjects. We have, therefore, determined the sensitivity of 68 subjects in order to find the range of individual differences, their statistical significance, and tentatively to account for them. On the basis of data from only four subjects König has declared the population to be divisible into two separate sensitivity groups which would form a bimodal distribution curve. With our 68 subjects we find no such bimodal segregation, but simply a normal distribution with a distinct massing about the median. We have selected typical distributions for the primaries and blocked them in Fig. 1. We have shown for the match to 580 mμ the distribution of the red component only (diagonal lines); for the match to 560 mμ the distribution of the green component only (horizontal lines); and for the match to 500 mμ the blue component only (stippled). These three are typical of the distribution of sensitivity for each component in all the matches, and illustrate the normal distribution of sensitivity in the population.

The cause of differences in sensitivity to the primaries has generally been attributed to varying amounts of macular pigment from subject to subject. If this were true, variations in matches should have been greatest in the yellow-blue direction. We, however, found variations to be greatest in the red-green direction. This circumstance, together with other relevant facts, obliges us to suppose that macular pigment is at most a secondary cause of variation, and that the fundamental cause is a genuine difference in the sensitivity of physiological function of the receptors themselves.

The three curves are a plot simply of the average sensitivity of the 68 observers for each match, and supply data which are of value in discussing the chromatic functions of the average eye, and in establishing colorimetric standards.

(2) The second aim of our investigation was to determine where the loss of saturation of mixtures begins, why it occurs and particularly to establish the precise conditions under which it occurs.

All previous workers have reported this desaturation for the mixtures which match an extensive region of the spectrum, and have gone so far in assuming it to be a universal quality of color vision under all conditions as to think it unnecessary to describe the experimental situation under which it has been observed. We also find a loss of chroma, but for a very restricted region of the spectrum. Why this difference? They have worked under artificial conditions. These do not simulate the situation in ordinary useful vision which involves an adaptation of the retina to an intensity similar to the intensity of the photometric field. They have employed dark-adaptation and so have unwittingly admitted scotopic factors which cause a desaturation of the field containing the shortest wave-lengths. This is, of course, the mixed field. As our work, on the contrary, was done under light-adaptation, this scotopic desaturation was escaped, and the conditions of ordinary useful vision were reproduced.

But loss of saturation may also be due to an "impure" green primary; that is, one of such short wave-length as to stimulate the blue sensory apparatus as well as the green. Such a desaturation is introduced, again unwittingly, because the choice of primaries is fallaciously assumed to be indifferent since, as it is thought, results based upon different sets of primaries may be equated by means of suitable algebraic transformations. Our careful choice of 517 mμ as the green primary which is most nearly "pure" has eliminated this desaturating factor. By using 517 we have similarly avoided the loss of chroma caused by a green of too long wave-length which would introduce desaturating red excitation.

Another problem which we have treated is how to regard the supposed desaturation of the yellow region of the pure spectrum itself. Here we are not dealing with a loss of chroma due to a mixing of stimuli, but with a supposedly inherent desaturation arising from the unmixed yellow itself. As desaturation is held due to the simultaneous stimulation of the sensory apparatus for the three primaries, the blue curve is extended far into the long-wave region of the spectrum, to explain this. We feel that this extension of the blue is merely a postulate which has derived its force from tradition, and that under critical examination it becomes unwarranted. It is difficult to see how a set of curves with the blue primary extending up into the red can be made to harmonize with the color mixture data which we present. Fig. 1 shows that blue does not extend above 517. Why, then, has it been the fashion to extend it? We can account for the extension when we observe that the supposed equal chroma cancelling power of the primaries in producing white is assumed to mean also equal luminosity of the processes elicited by the stimulation of each of the three mechanisms involved in white. But since the blue which is sufficiently intense to cancel yellow chroma is much less luminous than the yellow itself, it is erroneously held, therefore, that yellow contains blue; *i.e.*, is unsaturated in the usual sense. Thus the ascription of an intrinsic blue process in the yellow arises from the illegitimate application of terms representing chroma cancelling power to situations involving luminosity.

We believe that the Gordian knot may be cut by discarding the traditional definition of white, and assuming that red and green, when mixed alone, tend to cancel each other's chroma without the intervention of any blue process whatever. This leaves but little chroma for the blue to cancel when mixed with yellow. Consequently, no intrinsic blue process need be assumed to accompany yellow, and the extension of the blue curve into the yellow region need not be postulated.

W. F. HAMILTON
ELLIS FREEMAN

CHEMICAL COMPOSITION OF RICE AND ITS RELATION TO SOIL FERTILITY IN CHINA AND JAPAN

IN 1929 W. F. Gericke[1] offered a new explanation of the fact that oriental countries have been able to maintain a relatively high production of rice without the exhaustion of the soil similar to that caused "by continued cropping of land to cereals of occidental countries if practiced without fertilizers." On the basis of experiments in which rice was grown in nutrient solutions, he comes to the conclusion that the rices of the Asiatic countries have adapted themselves so that normal crops are produced with a low content of minerals, especially calcium, magnesium, phosphorus and sulphur. He does not make clear whether this holds only for orinetal rices or also for rice grown in other countries. If he meant that rice in general has a lower content of the mineral elements than do wheat, barley, etc., it would have been simpler to compare the respective chemical composition of these crops given in the literature instead of referring to his "minima" experiments. It is well known, for instance, that rice contains, as a rule, less nitrogen, phosphorus and potassium (the three essential elements which are generally applied in fertilizers) than do the staple cereals of this country, especially wheat. However, the average yield of rice in America, China, Japan and India is two or three times as high as that of wheat. Accordingly a crop of rice will remove from the soil at least as much plant food as a crop of wheat. The article would seem to indicate, therefore, that according to Dr. Gericke's belief the range of variation of the mineral content of oriental rices is considerably below the corresponding range of those grown on soils not exhausted by continuous cropping or grown with artificial fertilizers.

It seemed to us that a comparative analysis of Chinese and American rices could throw some light on such a hypothesis. We obtained from China samples of rice of five varieties and analyzed them for ash, nitrogen, potassium, phosphorus, calcium and magnesium. We also determined these elements in three samples of rice grown in this country and one sample grown in Porto Rico. The results, calculated on the air-dried basis, are given in Table I.

CHEMICAL COMPOSITION OF CHINESE AND AMERICAN RICES

		Percentage on Air-dried Basis						
No.	Origin	Ash	N	P_2O_5	K_2O	CaO	MgO	S
1	China	1.22	1.23	0.60	0.259	0.014	0.187	0.087
2	"	1.24	1.26	0.64	0.273	0.020	0.206	0.084
3	"	1.32	1.23	0.65	0.264	0.020	0.208	0.105
4	"	1.39	1.26	0.68	0.293	0.020	0.224	0.086
5	"	1.30	1.23	0.66	0.312	0.019	0.214	0.086
6	United States	1.58	1.44	0.76	0.314	0.025	0.244	0.091
7	" "	1.20	1.46	0.58	0.238	0.022	0.208	0.098
8	" "	1.58	1.46	0.76	0.328	0.020	0.235	0.099
9	Porto Rico	1.24	1.01	0.56	0.306	0.025	0.193	0.065

It is realized that these results are too meager to form a basis for definite conclusions, but these samples, picked at random, do not indicate any striking differences in composition between the Chinese rices, grown on a soil presumably cropped for thousands of years, and the rices grown under the American method of cropping.

Moreover, Dr. Gericke's explanation does not take into account nitrogen and potassium, which, with phosphorus, are most frequently the limiting factors in crop production. Calcium, magnesium, sulphur and iron are found in crops in relatively small quantities and are seldom applied as fertilizers. Furthermore, the late Professor F. H. King, in his book, "Farmers of Forty Centuries" (quoted by Dr. Gericke), claims that "these people (Chinese and Japanese) are now and probably long have been applying quite as much of these three plant foods (nitrogen, potassium and phosphorus) as are removed by the crop" (p. 190). It is true, then, that rice in China and Japan is grown under continuous cropping but not without restitution of plant food.

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[1] SCIENCE, 70; 1818, pp. 430–432.

SCIENCE

Vol. 75 FRIDAY, MARCH 18, 1932 No. 1942

The Filtration of Bacteria: PROFESSOR ARTHUR ISAAC KENDALL 295

Obituary:

Memorials; Recent Deaths 301

Scientific Events:

Psittacosis in California; Genetics Society of America; The Summer Session of the Chemistry Department of the Johns Hopkins University; Members Elected by the Washington Academy of Sciences; Presentation to Professor Conant 302

Scientific Notes and News 305

Discussion:

The Control of Injurious Animals: MAJOR E. A. GOLDMAN. *The Gastric Erosion of Metal:* FREDERICK HOELZEL. *Polydactylism in Mice:* DR. JOSEPH M. MURRAY. *Toxicity of Sodium Nitrate for a Species of Moss:* DR. A. B. BEAUMONT. *Prehistoric Mounds in South Florida:* JOHN C. GIFFORD and PROFESSOR ALFRED H. GILBERT 309

Scientific Books:

Comité national français de Géodésie et Géophysique: WALTER D. LAMBERT 313

Scientific Apparatus and Laboratory Methods:

A Holder for Chickens and Other Birds: DR. OSKAR SEIFRIED, DR. C. B. CAIN and HARRO WULF. *Freezing Technique for the Histological Study of Pigments in Amphibian Integument:* PROFESSOR RUSSELL L. ANDERSON 315

Special Articles:

The Cultivation of a Species of Troglodytella, a Large Ciliate from the Chimpanzee: E. C. NELSON. *The Experimental Transmission of Anaplasmosis by Dermacentor variabilis:* DR. CHARLES W. REES 317

Science News 8

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THE FILTRATION OF BACTERIA[1]

STUDIES IN BACTERIAL METABOLISM CIII

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INTRODUCTION

THE belief exists in some laboratories that bacteria, ordinarily deemed unfilterable, may under certain circumstances become so altered by chemical means, by cultivation for long periods of time in fluid media or through animal inoculation as to find their way through the pores of filters that would ordinarily restrain passage of the corresponding bacteria in their unfiltered state. The literature on this subject has become quite voluminous,[2] and opinion is now rather sharply divided into two groups; the "filtrationists," those who believe that bacteria may be filtered in some manner, and the "non-filtrationists," those who deny this possibility. This separation into two opposing camps is quite natural, because if one admits the possibility of filtration with one typical, ordinarily non-filterable microbe, one would rather logically be forced to admit that under suitable conditions all ordinary bacteria might be made filterable.

The problem of bacterial filterability has more than academic significance. There is a heterogeneous but formidable group of diseases of man and animals to which the term "filterable virus" is applied. The natural history of many of these "filterable virus" diseases—their clinical course, their method of dissemination and of inducing immunity—is generically akin to microbic diseases in which the etiological agents are presumably known, and cultivable in appropriate media. Up to this time, however, the incitants of this "filterable virus" group, whatever they may be, have not for the most part been cultivated unequivocally outside their respective hosts upon artificial, laboratory nutritives.

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[1] De Lamar Lecture, Johns Hopkins University School of Hygiene and Public Health, January 12, 1932.

[2] It is reviewed carefully by Klieneberger, "Bakterienpleomorphismus und Bakterienentwicklungsgänge," Erg. d. Hyg., Bakt., Immunitätsforsch. u. Exp. Therapie, Berlin, 11, 499–555. 1930.

It is surmised, and there is basis for this supposition, that the "viruses" of some of these diseases exist in the infected body in the filterable state, and it is not without some significance that many, if not most of these viruses enter, and probably leave the body, through the respiratory tract and its appendages. The possible import of this will be commented upon later. It is not proposed to discuss here the diseases allocated to the "filterable virus" group, but to present in detail some rather extensive studies upon the filterability of bacteria which may be relevant. These will be recounted at some length, as certain conclusions drawn from them would seem to indicate that the older division of microorganisms into "filterable viruses" and non-filterable bacteria may perhaps require some revision.

The experiments which led to the studies reported here have been described elsewhere in detail,[3] and will not be further referred to here, except for the statement that the first indication of the dual existence of an organism in a filterable and a non-filterable state was obtained from a study of blood from a small series of sporadic cases diagnosed clinically as influenza. A coccus was isolated from three of these cases in a special, protein-rich, peptone-poor medium (K medium);[4] at first in a non-visible, filterable state, and later apparently recovered after suitable procedure, as a visible, cultivable, non-filterable organism. From this wholly unexpected event, it was surmised that an actual, fundamental bacteriological principle was involved. If this be true, then other, well-established bacteria should also be rendered filterable experimentally, using the same general procedure, and recovered again in the non-filterable state.

Preparation of Culture

The organism chosen to test this premise was *B. typhosus*. The strain (Rawlin) was an old one, long in the laboratory. It has been used for many years in the customary manner for diagnostic purposes. It grows readily in plain, nutrient broth containing peptone and meat extractives. It also grows quite readily in the protein-rich, peptone-free K medium, prepared from hog intestine.[4] This is important. If the organism had failed to grow well in K medium, it would obviously have been less suited for these filtration experiments. The recital of an actual experiment with this strain of *B. typhosus* will make the procedure followed clear. Comments at the proper places will indicate the phenomena elicited. To insure purity in the usual bacteriological manner, this Rawlin strain of *B. typhosus* was replated three times upon agar. Between platings, growth from representative colonies was obtained in plain, nutrient agar. A colony from the last (third) plating was cultivated upon agar on October 29.

Filtration of Culture

Procedure

November 2. At 4 P. M. a generous loopful of this agar culture was introduced into 6 cc of K medium.[5] This was incubated at 37° C. over night.

November 3. Filtration I. At 10 A. M., growth being satisfactory, as estimated by a very distinct increase in turbidity above that of an uninoculated control, incubated in parallel, this 6 cc of K medium culture, after dilution with four volumes of sterile salt solution, was filtered through a Berkefeld "N" filter. (This filter did not pass a broth culture of *B. typhosus*). The vacuum used was less than 4 inches, water pressure, and the time of filtration was less than 10 minutes. The filtrate was clear. The filtrate was distributed at once, with sterile precautions, to the following media: to plain, nutrient broth; 1 cc, 1/2 cc, 1 drop; to K medium;[6] 1 cc, 1/2 cc, 1/4 cc, 1/10 cc, 1 drop. Incubation of these cultures together with uninoculated controls, was practiced at 37° C.

November 4. 10 A. M. Growth, as indicated by turbidity above parallel controls, occurred in all the tubes, both those in plain broth, and those in K medium. From the broth culture containing 1 drop of K medium filtrate, sugar fermentation reactions in glucose, lactose, saccharose and mannitol were made. After 24 hours, acid appeared in glucose and mannitol; saccharose and lactose were not acidified. An agar plate was also made. At the end of 24 hours, the colonies were typical and the culture appeared to be pure. Finally, after the sugar fermentation tests and agar plate had been started, a macroscopic agglutination test (dilution 1/500) was performed with this same broth culture. The culture agglutinated after 40 minutes' incubation at 37° C. An agar plate was also inoculated from the K medium tube which had received one drop of the K medium filtrate. The next day (November 5), typical colonies of *B. typhosus* were found in apparently pure culture. After transfer to broth, and proper incubation, they agglutinated with specific typhoid antiserum. Hence, from this first filtration, both the broth and the K medium tubes inoculated therefrom contained viable organisms which subsequently were identified as *B. typhosus* by plating, by fermentation reactions and by agglutination tests. The remainder of the tubes were reincubated for another 24 hours, together with their proper controls at 37° C.

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[3] Patten Lecture, "Observations upon the Filterability of Bactoria, Including a Filterable Organism Obtained from Cases of Influenza," *Northwestern University Bulletin*, Vol. 32, No. 5, 1931; SCIENCE, 74, 129–139, 1931.

[4] "Mediums for the Isolation and Cultivation of Bacteria in the Filterable State," *Northwestern University Bulletin*, Vol. 32, No. 8, 1931.

[5] 100 mg. dried intestine, 6 cc Tyrode solution, containing neither glucose nor glycerin. This mixture is thoroughly shaken to wet the dried intestine powder, and then sterilized in the autoclave, 15 pounds for 15 minutes. *This medium should be slightly turbid when cool.*

[6] 6 cc, prepared as indicated in footnote 5, was used.

November 5. Filtration II. 10 A. M. The tube of K medium which received 1/10 cc of the first filtrate (November 3), having a very noticeable turbidity after these 48 hours of incubation, was diluted with 4 volumes of salt solution and filtered through a Berkefeld "N" filter. The vacuum used was less than 4 inches, on the water-gauge, and the time required was somewhat less than 10 minutes. This filtrate was distributed as follows: to plain broth; 1 cc, 1/2 cc, 1 drop: to K medium; 1 cc, 1/2 cc, 1/4 cc, 1/10 cc, 1 drop. Incubation was practiced as before at 37° C.

November 6. 10 A. M. All cultures made November 5 grew; the plain broth cultures were distinctly less turbid than the corresponding ones of November 4. The K medium cultures, on the contrary, were rather more cloudy than the corresponding ones of November 4. Fermentation reactions were set up from the plain broth culture (that one inoculated with 1 drop of K medium filtrate of November 5); also an agar plate was inoculated. On November 7 the fermentation reactions were typical. The colonies on the agar plate were somewhat mucoid in appearance. An agglutination test (macroscopic, 1/500) made upon this broth culture was positive in 90 minutes. It will be recalled that the corresponding agglutination test made upon the broth culture recovered from the first filtration (November 3) was complete in 40 minutes. The growth in K medium failed to agglutinate in typical fashion, but a broth culture made from a K medium growth agglutinated characteristically. The significance of this observation, which has been repeated several times, is yet to be elucidated. From the results of this second filtration, it appears that there is some slight tendency both toward a change in the appearance of the colonies developing upon agar from broth inocula, and also a distinct tendency toward slowing of the speed of agglutination. Nevertheless, it is adduced that this second serial filtration of *B. typhosus,* and its recovery in the non-filterable state, was successfully accomplished.

November 6. 11 A. M. *Filtration III.* The K medium culture of November 5, containing one drop of filtrate, was diluted with 4 volumes of salt solution and filtered, this time through a Berkefeld "W" filter. The vacuum used was less than 5 inches on the water-gauge, and the time required was about 15 minutes. The filtrate was distributed as described above, in the following media: to plain broth; 1 cc, 1/2 cc, 1 drop: to K medium; 1 cc, 1/2 cc, 1/4 cc, 1/10 cc, 1 drop. Incubation was practiced at 37° C.

November 7. 9:30 A. M. The cultures in K medium all showed increased clouding above the control tube, which had been incubated in similar fashion. Of the plain broth tubes, on the contrary, none grew; at least there was no discernible turbidity at this time. Incubation of all the cultures was again practiced at 37° C.

November 9. Noon. The K cultures of November 6 had increased very distinctly in turbidity, and the broth culture of November 6, containing 1 cc of filtrate, had developed a faint but distinct turbidity. An agglutination test performed upon this broth culture, after inoculation of sugar fermentation tubes and agar plates, was partly clumped after 2 hours, and completely clumped after 18 hours in the ice-box. Agglutination of the cultures in K medium was negative. The colonies upon agar plates were rather mucoid in appearance. Sugar fermentation reactions were typical, but rather slow in developing. Recovery of the organism in its non-filterable state after each of these three several filtrations was achieved. The identification was made in each instance from growth induced in nutrient broth, by the appearance of colonies upon agar plates (test for purity), by fermentation reactions, and by agglutination (1/500) with specific antityphoid serum.

Each of the cultures made in K medium on November 6 was inoculated into plain broth, but even after 10 days' incubation, visible growth did not occur. It is assumed therefore that this serial, prolonged cultivation of *B. typhosus* in the protein (K) medium has resulted in an acclimatization of the organism in its filterable state to the protein medium, with a concomitant loss of accommodation to the simpler (peptone, meat extractives) medium. It has, in other words, become "proteophilic" instead of "peptophilic." It is surmised that a principal function of this filtration through the Berkefeld "N" and "W" filters is to strain out, and hold back, the non-filterable forms of the organism, passing those forms which not only are indeed filterable but also which have become more and more acclimatized to the protein environment. The final result of these three serial filtrations is apparently to establish culturally this filterable, protein-cultiviable form of the organism, which is reluctant to grow in ordinary media. To answer the obvious inquiry at this point: recovery of the bacillary form was eventually achieved through inoculation of this filterable state of *B. typhosus* upon plain, nutrient agar, after incubation under partially anaerobic conditions for several days. The details will appear later. For the present, the point at issue is the premise that *B. typhosus* is, or may be, filterable if it is cultivated for several transfers in a "protein" (K) medium. Also, that it may be recovered in the non-filterable (peptophilic) form as above indicated.[7]

The subsequent history of this thrice filtered culture of *B. typhosus* and its maintenance in the filterable state is as follows: the tube of K medium inoculated November 6, *containing one drop of filtrate* of that date, was used. Transfers were made to fresh K medium November 9 and November 12, respectively, with incubation at 37° C. between times. The next transfer was made in California, November 16, and daily thereafter through November 22. With the exception of November 13, 14 and 15, during which time the culture was in transit, incubation of the subcultures was practiced at 37° C. From November 22 to November 28, the organism was again in transit, but reinoculation and reincubation were resumed on this date. On January 4 the strain is still alive. It still grows in K medium, but not at all in nutrient broth. It has retained its proteophilic properties, and apparently has not regained its original peptophilic state, as manifested by lack of visible growth in nutrient broth, even after several days' incubation. Thus, so it appears, a viable organism in the filterable state, incapable of visible growth in plain, nutrient broth, has been obtained by direct descent in culture through serial growth in an artificial, sterilizable medium (K medium) from an authentic, typical, plain nutrient broth culture of *B. typhosus.* It is left to the microbic pragmatists and dialecticians to debate whether or not this viable, cultivable, filterable organism thus obtained fulfils any, some or all of the criteria of a "filterable virus."

SUMMARY

This detailed protocol has been recited in considerable length because it contains what appears to be unequivocal evidence that a strain (Rawlin) of *B. typhosus* has been filtered not once, but actually thrice serially through Berkefeld filters, the first two filtrations through Berkefelds of N porosity, the third filtration through a Berkefeld of the W porosity, making three filtrations in all in a period of four days. These filtrations were performed on November 3, 5 and 6, respectively. Between filtrations, and prior to each of them, growth was elicited in K medium. The organisms developing after the first, the second and the third filtrations (November 3, 5 and 6) were recovered successively in the non-filterable state in nutrient broth and tested for their identity and purity by sugar reactions, by agglutination with specific typhoid serum and by plating upon agar. These tests were performed not only with the cultures of filtrates in plain nutrient broth, but also with subcultures made from K medium, in plain nutrient broth, with the exception of the K culture from the third filtration. This failed to grow in nutrient broth, although it grew well in successive K medium transfers.

Concerning the proportion of filterable to non-filterable forms, no definite information is available. However, inasmuch as the cultures were diluted with salt solution to 1/5 their original concentration prior to filtration, and inasmuch as 1 drop and 1/10 cc, respectively, of the diluted filtrates gave growths that were subsequently identified as *B. typhosus,* by fermentation reactions, by agglutination and by plating, it may be assumed that at least 1/50 cc of the unfiltered cultures in K medium contained viable typhoid microbes in the filterable state.

COMMENT

Imperfect filters: The old familiar contention that the filters which were used may have leaked, must be resurrected at this point. The theoretical possibility of leaky filters must always be admitted, and, except for two significant facts, it should be freely admitted in these experiments. Overlooking for the moment the fact that a filterable organism, incapable of growing in nutrient broth, was obtained through filtration, as above indicated, attention is directed to the fact that the filters used in these studies had been tested previously for passage of broth cultures of *B. typhosus* with negative results; hence it is assumed that the organisms do actually become filterable under the conditions specified, although the possibility still remains that the porosity of these tested filters may have changed in the interim. Also, and this may be significant, the broth culture made from the filtrate in broth (1 cc) of November 5, likewise failed to pass through one of the "N" filters used for these experiments. It is rather generally believed that Berkefeld "W" filters are too fine to pass bacteria. Attention is directed at this point to Bechhold's[8] important contribution to relations between size of pores in filters (*cf.*, Berkefeld N and W, p. 416) and their capacity to withhold bacteria under definite conditions.

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[7] It is pertinent to inject here the rather obvious comment that the time relations met with in filtration experiments vary not only with the kind of organism, but also with the strain itself. Thus, one typhoid strain studied became "proteophilic" after one filtration; and another strain required four filtrations at two day intervals to become "proteophilic."

[8] H. Bechhold, "Porengrosse von Bakterienfiltern und Siebwirkung," *Zeit. f. Hyg. u. Infektskr.*, 112, 3 Heft, 1931.

The other rejoinder to the plea of leaky filters, and, coincidentally perhaps the most suggestive new idea developed in these experiments, aside from the filterability and recovery of the non-filterable form of *B. typhosus*, is the gradual weaning of the filterable form of *B. typhosus* from its original (peptophilic) state, in which form it is non-filterable, to the filterable (proteophilic)[9] state, in which form it appears eventually to pass quite readily through even the finest Berkefeld (W) filter. In the peptophilic state, the organism grows readily in nutrient broth. In the fully established filterable state, achieved only by a sufficient number of serial filtrations to eliminate the peptophilic organisms, the microbe fails to grow in nutrient broth. It grows very well, however, in K medium.

It is, therefore, apparently a simple, rather rapid procedure to induce the filterable state by inoculation into K medium. Once the organism, freed from non-filterable tendencies by repeated filtration with inter-cultivation in protein (K) medium, has become accustomed, or better acclimatized, to the protein pabulum, it becomes increasingly difficult, at least in these experiments, to reinduce the non-filterable state.

At this time, an unexpected experience in the filtration of a culture of *B. coli* seems pertinent, in that it illustrates some of the pitfalls associated with the phenomena of microbic filtration. This particular strain of coli was isolated in 1909, and has been in laboratory stock ever since. The first attempt at filtration resulted in recovery of a small, yellow coccus. The yellow coccus was devoid of glucose fermenting power. Repeated platings of the original culture upon agar failed to reveal this coccus. Finally, resort was made to cultivation in K medium for 30 hours prior to plating. Then about 2 per cent. of the colonies on agar were of this yellow coccus, the remainder being typical coli. The K medium had been shown to be sterile prior to inoculation. Filtration of the purified colon bacilli, had by plating from K medium, was accomplished in good form, and the organism was filtered three times in five days with intervening growth in K medium. Between filtrations, typical *B. coli* were recovered and identified by fermentation reactions. For comparison, another stock culture of *B. coli* was examined. It failed either by direct plating, by plating after growth in K medium, or upon filtration, to reveal this yellow coccus. The possibilities enmeshed in this experience with the yellow coccus are many; space forbids more than mention of the facts as they were observed at this time.

MORPHOLOGICAL CHANGES DURING FILTRATION

Returning to the filtration of *B. typhosus*, the question very naturally arises, Are there changes discernible in the typhoid bacilli during the process of inducing the filterable state that may actually be seen under the microscope? One rather suggestive difference between the appearance of the first growth of *B. typhosus* in K medium immediately prior to filtration, and of the organism after filtration, is the relative abundance of bacillary forms, with and without granules within their substance, in the former, as shown by staining with old methylene blue, by examination with the 1/12 immersion lens directly and by dark-field illumination. This is sharply in contrast to the apparent absence of these bacillary forms, with and without granules, in the filtrate immediately *after filtration*. In both the unfiltered *primary* growth in K medium and in the filtrate of this primary K medium culture, however, there are numerous granules. Some of these granules are inherent in the medium.[10] They are bluish or greenish yellow under dark-field illumination, and usually exhibit Brownian movement. In addition, in both filtered and non-filtered K medium cultures of *B. typhosus*, there are usually small, somewhat motile granules. These are, in fresh culture in K medium, often nearly as active in their motion as typhoid bacilli themselves. It must not be assumed from this observation that the filterable forms of all bacteria will exhibit true motility, however.

In the filtered medium, these granules and not the bacillary forms, appear to be the only motile bodies. Thus far, they have not been definitely stained, even by Giemsa or silver stains, and their identification therefore depends rather upon inference than upon rigorous proof.

It is necessary to reemphasize here that repeated filtration of cultures of *B. typhosus*, with interspersed cultivation in K medium, is required to eliminate the tendency of the filterable forms to go back to the bacillary form. As acclimatization progresses, with repeated filtration for the purpose of the elimination of the non-filterable forms, a time comes, usually after two or more successive filtrations at appropriate intervals, when the filterable (proteophilic) forms no longer respond to the "peptone urge" and remain viable, but filterable from culture to culture in K medium. Such "proteophilic" organisms, in the filterable state, are difficult indeed to reestablish in the non-filterable condition. A condition similar to this may be readily conceived of as existing in the tissues of the animal or human body, where invading bacteria, originally non-filterable, exposed for periods of time to the tissue protein in absence of peptones, may thus become proteophilic, parasitized upon the proteins of the body, as it were, and difficult to recultivate in peptone media. Emphasis is laid at this point upon the biological significance of inducing this filterable state through cultivation of bacteria in media rich in nearly unaltered protein. In this respect, the experiments recorded above differ sharply from previous procedures in which strontium salts, or very old peptone broth cultures are relied upon to induce filterability.

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[9] Throughout this discussion, the terms "peptophilic" and "proteophilic" are used symbolically to suggest rather definitely a chemical difference between peptone on the one hand, and the more or less unaltered protein constituents of dried intestine on the other hand.

[10] It will be found that cultures grown in broth usually contain at least some bacilli with enclosed granules, and all media containing protein ingredients will contain at least some free granules. These, in uninoculated media, are non-motile, although they usually exhibit Brownian movement.

Thus far, emphasis has been laid upon actual experiments. It has been found that *B. typhosus*, under cultivation in a protein-rich, peptone-poor medium passes rather rapidly and readily to the filterable state. While it can not be dogmatically denied that leaky filters permit of this passage, the fact that five different strains of *B. typhosus* (to restrict discussion to this organism for the present) have been thus filtered and recultivated, using some 24 different filters of the Berkefeld type, each time employing the finest pored filter (W) for the final separation of non-filterable forms, would appear to be reasonable evidence of the accuracy of the assertion. The part played by filtration in these experiments is merely passive. It removes those filterable, lineal descendants of the original stock culture which still manifest a tendency toward reversion into typical, non-filterable bacilli, under the nutritional stimulus of peptone, from the filterable forms, which have developed, so to speak, proteophilic propensities.

RELATION OF THE FILTERABLE STATE TO INFECTION

Some interesting correlative information arises from this nutritional concept of the development of filterable forms of bacteria from non-filterable forms in the body itself, especially in relation to microbic infection.

Microbic infection, generally speaking, may be considered as actually taking place when the prospective invading organism passes through the barriers which usually suffice to keep it out, and actually penetrates into the protein fastness itself. A majority of bacteria, and presumably a majority of "viruses," gain entrance to the underlying tissues through epithelia, principally those of the intestinal and the respiratory tracts. A significant chemical difference between these two tracts should be emphasized here. The intestinal mucosa is almost continually bathed, on the epithelial side, in a medium rich in protein digestive products, which pass successively from the complex peptones and albumoses to simple peptids and amino acids. The latter, according to current information, are normally absorbed from the alimentary canal through the villi, and pass to the blood stream. Hence the mucosa of the intestinal tract is in a peptone environment, using the term "peptone" symbolically merely to indicate protein in various stages of digestion. The nutritional value of this medium is reflected in the luxuriance of the intestinal flora: some thirty trillions of visible and stainable bacteria are said to be eliminated each day in the fecal mass of a normal adult enjoying a normal diet. The respiratory tract, on the contrary, is a relatively sterile tract. Protein degradation products, except at those times when purulent bacteria are at work, are apparently absent. The significance of mucus in this connection can not be answered in light of available information. Stated somewhat differently, the digestive tract is proteolytic; the respiratory tract is aproteolytic. Bacteria that enter the digestive tract find abundance of protein digestion products available for their nutrition: bacteria that enter the respiratory tract do not normally find protein digestion products available for their nutrition. It would seem to follow that bacteria within the intestinal tract are in an environment that should tend to encourage their existence in a non-filterable (peptophilic) state. Bacteria that gain entrance to the respiratory tract would appear to be in an environment that normally should tend to encourage their existence in a filterable (proteophilic) state.[11] In light of this rather striking difference between the two tracts, it is not without significance that many if indeed not most of the contagious so-called "filterable viruses" according to current information appear to enter, and to leave, the body through the respiratory rather than the intestinal path.

Microorganisms that pass from the respiratory tube actually into the tissue of the lung, whether they are initially filterable or not, become confronted with a protein-rich, peptone-poor medium, as they penetrate the epithelia of the respiratory tract. From what has been stated above, this is one condition which tends to induce and to perpetuate the filterable state. Similarly, upon passing back from lung tissue to the respiratory tube, the same condition apparently prevails unless there is pus formation. Pus, as is well known, contains products of protein digestion. It would seem to follow logically that bacteria in the filterable state should, theoretically at least, be not uncommon in non-purulent infections of the respiratory tract. Bacteria leaving the body from the intestinal tract, on the contrary, are exposed to nutritive conditions conducive to the non-filterable rather than the filterable state. Hence it is perhaps not necessary to reiterate that many, if not most, of the "filterable viruses" have been found thus far in association with the respiratory, rather than the intestinal tract. This is not to be construed as an assumption that all "filterable viruses" exist in a non-filterable as well as a filterable state: only precise experiments with each disease entity will determine just what the limits to be applied ultimately to the term "filterable virus" shall be: nor is it by any means the whole story. *B. coli*, like *B. typhosus*, seems to become filterable without much difficulty by cultivation in the proper manner in protein media, but the fact that this microbe may thus become filterable does not explain why it is not ordinarily an invader of the body. The nature of the weapons with which certain kinds of bacteria, and not others, may force entrance through the epithelia which ordinarily suffice to keep microbes out, is yet to be determined. Just what part the filterable state of bacteria may play in the vastly complex phenomena of infection and immunity remains to be revealed. And there are exceptions to this hypothesis of association between protein nutrition and the filterable state. Leprosy appears to be such a case. Leprosy bacilli are readily stained within the tissues of lepers; that is, they exist there in a presumably non-filterable state. There is little evidence that there is much, if indeed any, tissue digestion round about them. Nevertheless, exceptions to the contrary, there is after all apparently a very distinct general biological parallelism between the occurrence of non-filterable, stainable bacteria, growing in ordinary media under the nutritional stimulus of peptone (peptophilic state) and filterable, not stainable organisms growing in protein-rich, peptone-poor media under the nutritional stimulus of protein (proteophilic state). And the well-established difficulties surrounding the isolation of microbes from some of the so-called "filterable viruses" (which appear to be developing in the protein tissues of the body and are refractory to cultivation in peptone media, even enriched with tissue) have their nearly precise counterpart in this connection with the corresponding experimental difficulties encountered in cultivating the fully protein acclimatized, filterable form of *B. typhosus* in peptone media, even those enriched with blood. It would appear indeed that one rather striking feature of the experiments with filterable forms of the typhoid bacillus is this very establishment of the proteophylic state, refractory to cultivation in ordinary, or enriched peptone media. If this indeed be the case, then it might be rather confidently predicted that at least some of the infections refractory to artificial cultivation should be approachable from the use of suitable protein media. A word about K medium should be injected at this point: it is very crude. This has been emphasized again[3] and again.[4] There is no more reason, *a priori*, for expecting successful isolation of organisms from influenza, common cold and smallpox, to mention three possible sources of culture, in K medium in its present crude state, than there is in expecting successful isolation of *Tr. pallidum*, meningococcus and tubercle bacillus, using merely plain, nutrient broth. Special modifications, to meet the needs of specific organisms, both for isolation and for cultivation of specific organisms in a filterable state, must be applied to the medium, as is required of the usual laboratory media for similar reasons. This is well exemplified by the recent work of Mellon,[12] who has just reported the successful filtration of the tubercle bacillus, and its recovery in the non-filterable state, using a modified K medium.

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[11] The pneumococcus, a frequent incitant of pneumonia, is habitually a purulent organism. Pus is said to be rich in protein degradation products.

CONCLUSIONS

(1) The intimate details of three successive filtrations of an authentic strain of *B. typhosus*, performed in four days, are recorded.

(2) The details of recovery of *B. typhosus* in the non-filterable state, and its identification by colony formation, by fermentation reactions, and by agglutination tests, are stressed.

(3) Attention is drawn to the perpetuation of *B. typhosus* in the filterable state by cultivation in a protein [K] medium.

(4) Emphasis is laid upon the biological significance of proteins in inducing the filterable state in bacteria.

(5) Certain theoretical relationships are suggested between this artificially induced filterable state of bacteria and certain microbic infections of man.

OBITUARY

MEMORIALS

THE section on medical history of the College of Physicians of Philadelphia, as reported in the *Journal* of the American Medical Association, held its stated meeting on March 14, in cooperation with the Henry Phipps Institute, the Philadelphia Health Council and Tuberculosis Committee and the Philadelphia Association of Tuberculosis Clinics to commemorate the fiftieth anniversary of the discovery by Robert Koch, *March 24, 1882, of the tubercle bacillus.* Addresses *were made by Drs. Henry R. M. Landis,* on "Reception of Koch's Announcement in the United States"; Theobald Smith, Princeton, N. J., "Koch's Views on the Stability of Species among Bacteria"; Lawrason Brown, Saranac Lake, New York, "What Koch Meant to Tuberculosis," and Damaso de Rivas, "Personal Reminiscences of Robert Koch."

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[12] Mellon, *Proc. Soc. Exper. Biol. and Med.*, Vol. 29, No. 2, p. 206, 1931.

CONTRIBUTIONS are invited to a memorial to Sir Andrew Balfour, first director of the London School of Hygiene and Tropical Medicine, who died a year ago. The medical men supporting the appeal include: Sir James Crichton-Browne; Sir Matthew Fell, late Director-General A.M.S.; Professor W. W. Jameson, dean of the London School of Hygiene and Tropical Medicine; Colonel P. S. Lelean, professor of public health, Edinburgh University; Dr. A. T. Stanton, chief medical adviser to the Secretary of State for the Colonies; and Dr. C. M. Wenyon, director-in-chief, Wellcome Bureau of Scientific Research.

A DINNER of the Royal College of Surgeons, at which the Lord Mayor of London was a guest, was held on February 11 to commemorate the two hundred and fourth anniversary of the birth of John Hunter. Dr. David Ross, the president, was in the chair. The toast "The Memory of John Hunter" was honored in silence. The president said that the presidential chair in which he sat would eventually be presented to the Royal College of Surgeons. He recounted the activities of the society during the past year and concluded by presenting Dr. Griffith Ifor Evans, of Carnarvon, with the Hunterian Medal, the first struck in gold, for an essay on "Chronic Familial Syphilis." The medal, he said, has been designed by Mr. W. Thornton Shiells, and a plaque was presented by the honorable treasurer, Dr. Irwin Moore.

RECENT DEATHS

HARVEY M. HALL, staff member of the division of plant biology of the Carnegie Institution of Washington, a student of botany and ecology, died on March 11 at the age of fifty-eight years.

A CORRESPONDENT writes: "Dr. Charles Ford Langworthy died in Washington on March 3 at the age of sixty-seven years. Dr. Langworthy was a chemist and was for many years one of the foremost workers in America on nutrition problems. During most of his active life he was connected with the U. S Department of Agriculture, first as associate editor of the *Experiment Station Record* and later as chief of nutrition investigations and chief of the Office of Home Economics."

MARY FRANCES SEYMOUR, professor of biology in Catawba College, Salisbury, N. C., since 1925, died on March 2. Professor Seymour was associate professor of biology at the North Carolina College for Women, Greensboro, N. C., 1916–1923.

A CORRESPONDENT writes: "Professor A. A. Jaczewski, eminent Russian mycologist and plant pathologist, died in Leningrad on February 12. Dr. Jaczewski organized and was director of the Jaczewski Institute of Mycology and Plant Pathology, which was, in this field, the central institute of all Russia. Dr. Jaczewski visited the United States in the summer of 1921. He was well and widely known for his texts and other scientific contributions. In the fields of systematic mycology and plant pathology he has long been recognized as the outstanding research leader and teacher of Russia."

SCIENTIFIC EVENTS

PSITTACOSIS IN CALIFORNIA

ON the basis of recent deaths from psittacosis in California, and positive findings in parrakeets from various parts of the state made by Dr. K. F. Meyer, of the Hooper Foundation for Medical Research of the University of California, the State Department of Public Health has adopted new rulings concerning the handling of parrakeets.

One of the new regulations makes psittacosis a reportable disease, and another restricts the importation and exportation of love birds and birds of the parrot family. The latter regulation reads in part as follows:

> Whereas, It has been determined that birds belonging to the parrot family and infected with disease, and love birds so infected have infected other birds of the same family and that some of said birds have been infected with disease which may be transmitted to man; and
>
> Whereas, It has become necessary to take action to prevent further infection of such birds in California and thereby prevent the extension of the disease to human beings; therefore, be it
>
> Resolved, by virtue of the authority vested in this board by section 2979 of the Political Code of California, that the importation into and the exportation from the State of California of all birds of the parrot family and love birds, be prohibited for a period of not to exceed six months; provided that shipments of such birds from a foreign country consigned to another state or consigned from another state to a foreign country or consignments of such birds between other states, may be

permitted to pass through California if under official seal.

The *Weekly Bulletin* for February 20, of the State Department of Public Health says: "A brief summary of the psittacosis situation in California during the past few months reveals the appearance of twelve cases and six deaths. These patients had in every instance except one been in contact with recently purchased parrakeets, most of which were purchased from itinerant bird venders.

"The laboratory work in connection with these cases was done by Dr. F. K. Meyer at the Hooper Foundation for Medical Research. Positive findings were reported in parrakeets from Grass Valley, San Luis Obispo, Woodland and San Francisco. Not all of these parrakeets had been associated with cases in human beings. Positive results were obtained also from autopsy specimens from one of the patients who died of psittacosis."

GENETICS SOCIETY OF AMERICA

AT the recent New Orleans meetings, the genetics sections of the American Society of Zoologists and the Botanical Society of America were reorganized as the Genetics Society of America. The group known as the Geneticists Interested in Agriculture was discontinued with the understanding that symposia of interest to agriculturists will be held by the new society. Dr. R. A. Brink was chosen to cooperate with the society officers in organizing this part of the program.

The executive committee of the society consists of the following officers and past chairmen: L. C. Dunn, *president;* F. D. Richey, *vice-president;* P. W. Whiting, *secretary-treasurer;* L. J. Stadler, *past chairman;* L. J. Cole, *past chairman.* The society now consists of 289 members of whom 153 are also members of the American Society of Zoologists and 90 are members of the Botanical Society of America.

The officers of the society urge members to suggest to any of their acquaintances who are interested in any field of genetics to apply for membership. Names endorsed by two members may be sent to the secretary at any time. Teachers of genetics, advanced graduate students, and research assistants who may be interested in attending the meetings or in receiving copies of abstracts giving the latest results of investigations are welcomed to membership. It is particularly urged that Canadians or others who may be so situated as to be able to attend the meetings will not hesitate to apply for membership.

It is expected that the meetings will be conducted very similarly to those that have been previously held by the genetics sections. The executive committee will, however, welcome suggestions from members in reference to program rules or any other affairs of the society. All suggestions mailed to the secretary will be circulated among the other members of the Executive Committee for their consideration.

Copies of the constitution and by-laws will be sent upon request. Annual dues are $1.00. Copies of programs and abstracts of papers to be presented at the annual meeting will be furnished without charge to members in good standing.

P. W. WHITING,
Secretary-Treasurer

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF PITTSBURGH,
PITTSBURGH, PA.

THE SUMMER SESSION OF THE CHEMISTRY DEPARTMENT OF THE JOHNS HOPKINS UNIVERSITY

AN experiment in graduate work is to be initiated in the chemistry department of the Johns Hopkins University during the summer session of 1932, in order to provide a unique opportunity for teaching and industrial chemists to confer with authorities of national and international repute on "Recent Developments in Chemistry." The work is planned as a series of conferences covering a period of five weeks, each week to be devoted to a particular phase of chemistry. This special course is in addition to the regular theoretical and laboratory courses in general, physical, organic and analytical chemistry, and arrangements have been made for those on limited leave to register for only one week, if so desired. In addition to the regular registration fee of three dollars, a nominal fee of five dollars per week will be charged. The complete series may be taken as a graduate credit course, without additional charge to students regularly registered in the summer session.

The conferences on "Recent Developments in Chemistry" will be directed by members of the graduate faculty whose work will be supplemented by invited lecturers. The program is as follows:

Program

June 27 to July 1: ''Raman Effect and Problems in Molecular Structure,'' directed by D. H. Andrews. The week will close with a general discussion grouped around papers by the invited lecturers—Harold C. Urey, Oliver R. Wulf, John R. Bates, Henry Eyring and H. M. Smallwood.

July 5 to 9: ''Colloidal Chemistry,'' directed by W. A. Patrick. A special lecture will be given on ''The Colloidal Behavior of High Polymers,'' by Elmer O. Kraemer.

July 11 to 15: ''Catalysis,'' directed by J. C. W. Frazer.

July 11 and 12: J. C. W. Frazer, ''Structure of Catalysts; State of Adsorbed Molecules; Mixed Catalysts; and Poisoning of Catalysts.''

July 13: A. B. F. Duncan, ''Absorption of Gases or

Solids; Form of Adsorption Curves; Heat of Adsorption; and Activation Energy of Adsorption and Rate of Adsorption.''

July 14: Louis S. Kassel, ''Heterogenous Reactions.''

July 15: Paul H. Emmett, ''Studies on the Mechanism of Ammonia Synthesis Over Iron Catalysts.''

July 15: A. T. Larson, ''The Methanol Synthesis.''

July 18 to 29: ''Relation of Properties to Constitution of Organic Compounds,'' directed by E. Emmet Reid.

THEORETICAL

July 18 to 22: ''The Relation of Structure to Physical Properties, Melting and Boiling Points, Optical Activity, etc., and to Chemical Properties, such as Reactivity.''

July 18: E. Emmet Reid, ''Introduction to Week's Work.''

July 19: E. Emmet Reid, assisted by F. O. Rice's students, ''Free Radicals.''

July 20: M. S. Kharasch, ''The Use of the Electronic Theory in Elucidating Reactions in Organic Chemistry.''

July 21: P. A. Levene, ''Chemical Structure and Optical Activity.''

July 22: C. S. Hudson, ''An Extension of Emil Fischer's Proof of the Configurations of the Sugars.''

APPLICATIONS

July 25 to 29: ''The Designing of Organic Compounds for Specified Purposes as Illustrated in Chemotherapy and in the Arts.''

July 25: E. Emmet Reid, ''Introduction to Week's Work.''

July 26: David I. Macht, ''The Present Status of Possibilities and Limitations in Regard to the Relationship between Chemical Structure and Physiological Action.''

July 27: H. J. Barrett, ''Relation of Resin Formation to Structure.''

July 28: H. A. Lubs, ''Relation of Color to Constitution in the Thioindigoid Dyes.''

July 29: R. E. Rose, ''The Relation of Structure to the Color of Dyes.''

OTHER FEATURES

Another course of interest to chemistry teachers will be that in "Undergraduate Curriculum Content." This will be worked out to develop an improved curriculum for undergraduate chemistry students and will be conducted to some extent in connection with the conferences on "Recent Developments in Chemistry." Attendance at the latter will not be required, but will be encouraged as providing an opportunity for teachers to select at first hand and to organize material from up-to-date developments. Registrants in the course on "History of American Chemistry" will have the privilege of conferring with Dr. C. A. Browne, authority in the field of historical chemistry.

The following sound films will be presented as public lectures during the summer:

June 30: ''Cosmic Rays,'' by R. A. Millikan.

July 14: ''Oil Films on Water,'' by Irving Langmuir.

July 28: ''Some Biochemical, Pharmacological and Medical Experiences as Told to Chemists,'' by J. J. Abel.

MEMBERS ELECTED BY THE WASHINGTON ACADEMY OF SCIENCES

THE following have recently been elected to membership in the Washington Academy of Sciences:

HONORARY MEMBER

Sir James Hopwood Jeans has been made an Honorary Member in recognition of his contributions to the dynamical theory of gases, to cosmogony, and to astrophysics. His brilliant applications of mathematical physics to the problems of astronomy have made him one of the leaders in the recent great advance in that science. Among his important publications are the following books: "The Dynamical Theory of Gases," "Problems in Cosmogony and Stellar Dynamics," and "Astronomy and Cosmogony." He is a research associate of the Carnegie Institution of Washington.

MEMBERS

Dr. Frederick Sumner Brackett, director of the division of radiation and organisms, of the Smithsonian Institution. Dr. Brackett is well known for his investigations in spectroscopy, including the development of thermopiles, and for his researches on plants and radiation, the results of which have been published in various journals.

Members newly elected to the Washington Academy of Sciences are characterized in the *Journal* of the academy as follows:

Dr. Robert Herman Bogue, research director, Portland Cement Association Fellowship at the Bureau of Standards. Dr. Bogue was elected to membership in recognition of his contributions to colloid chemistry and to the physical chemistry of silicates. He is the author of numerous papers on these subjects.

Professor Oakes Ames, professor of botany, supervisor of Biological Laboratory and Botanical Garden (Cuba), Arnold Arboretum and Botanical Museum, Harvard. Professor Ames was elected to membership in recognition of his contributions to systematic orchidology. He is the preeminent authority in this large and exceedingly difficult group of plants.

Dr. Thomas Barbour, director of the Museum of Comparative Zoology. Dr. Barbour was elected to membership in recognition of his contributions to herpetology and ornithology.

Dr. Johannes Hadeln Bruun, research associate at the Bureau of Standards. Dr. Bruun was elected to membership in recognition of his work on the separation and identification of the constituents of petroleum, the results of which have been published in various journals.

Charles Allen Cary, physiological chemist, Research Laboratories, Bureau of Dairy Industry. Mr. Cary was elected to membership in recognition of his contributions to the knowledge of nutrition and particularly the protein metabolism of milking cows. He is the author of numerous papers on these subjects.

Henry B. Collins, Jr., assistant curator, Division of Ethnology, U. S. National Museum. His election to membership was in recognition of his archeological researches in the southeastern section of the United States and in Alaska, and his contributions to physical anthropology.

Dr. James Fitton Couch, chemist, Bureau of Animal Industry. Dr. Couch was elected to membership in recognition of his work on the active principles of stock-poisoning plants. The results of his work have been published in various journals and bulletins.

Dr. Carl S. Cragoe, physicist, Bureau of Standards. Dr. Cragoe was elected to membership in recognition of his work on the thermodynamic properties of ammonia and of petroleum products.

Dr. Leon Francis Curtiss, physicist, Bureau of Standards. Dr. Curtiss was elected to membership in recognition of his investigations in radioactivity and cosmic radiation.

Dr. Francis Marion Defandorf, physicist, Bureau of Standards. Dr. Defandorf was elected to membership in recognition of his contributions to the science of electrical measurements, particularly in the field of high voltage.

Herbert N. Eaton, acting chief of the hydraulic laboratory, Bureau of Standards. Mr. Eaton was elected to membership in recognition of his work in aeronautics and hydraulics. He has written numerous articles on aeronautic instruments.

PRESENTATION TO PROFESSOR CONANT

THE William H. Nichols Medal of the New York section of the American Chemical Society for 1932 was presented on March 1 to Professor James Bryant Conant, chairman of the division of chemistry at Harvard University, in recognition of his work in organic chemistry, particularly in the chemistry of chlorophyll.

Professor Arthur E. Hill, of New York University, made the presentation. Other speakers were Professor James F. Norris, of the Massachusetts Institute of Technology, who discussed Professor Conant's personal career, and Professor Hans T. Clarke, of the College of Physicians and Surgeons, Columbia University, who recounted his scientific accomplishments. Mr. Walter S. Landis, chairman of the New York Section of the American Chemical Society, presided.

The Nichols Medal, established in 1903, is one of the most distinguished honors in American chemical science. The award, made for the research published during the past year, which in the opinion of the jury is most original and stimulative to further research, was bestowed on Professor Conant for his work in organic chemistry, particularly in the chemistry of chlorophyll. The late Dr. Nichols, the donor, was chairman of the board of the Allied Chemical and Dye Corporation and a charter member of the American Chemical Society.

Past winners include Professor William Lloyd Evans, of the Ohio State University, who received it in 1929 in recognition of his research into the structure of the sugar molecule; Dr. Samuel Edward Sheppard, assistant director of the research department of the Eastman Kodak Company, who was medallist in 1930, for his work in the chemistry of photography, and Dr. John Arthur Wilson, of Milwaukee, honored in 1931 for achievement in colloid chemistry, applied particularly to leather and sanitation.

Professor Conant, who was born in Boston in 1893, is a graduate of Harvard University, where he received the A.B. in 1913 and the Ph.D. in 1916. He served during the war as lieutenant in the Sanitary Corps, and later became major in the research division of the Chemical Warfare Service. An assistant professor of chemistry at Harvard after the close of the war, he became associate professor in 1925, and full professor in 1927. He is a former chairman of the organic division of the American Chemical Society. He is the author of "Organic Chemistry," joint author of "Practical Chemistry," and editor-in-chief of Volumes II and IX of "Organic Syntheses." His research has included work in reduction and oxidation, hemoglobin, free radicals, a quantitative study of organic reactions, besides the chemistry of chlorophyll.

SCIENTIFIC NOTES AND NEWS

APPOINTMENT of Dr. Vannevar Bush as vice-president of the Massachusetts Institute of Technology was announced by President Karl T. Compton following the regular meeting of the corporation on March 9. He has been a member of the faculty of electrical engineering since 1923. Dr. Bush was also elected a member of the corporation and will be dean of engineering. Plans have been made for the subdivision into the School of Science, the School of Engineering, the School of Architecture, the Division of Humanities and the Division of Industrial Cooperation. Dr. Samuel C. Prescott, head of the department of biology and public health, will be dean of science, and Professor William Emerson, head of the department of architecture, will be dean of architecture.

Dr. Thomas Howell, superintendent of the New York Hospital since 1909, has been appointed assistant director of the New York Hospital-Cornell Medical College Association. The association is the coordinating agency which will open the new medical center of the two institutions, between Sixty-eighth and Seventy-first Streets, along the East River, on September 1. Dr. Howell will have charge of the general hospital activities, particularly of financial management.

Dr. Roland Thaxter, emeritus professor of cryptogamic botany, and honorary curator of the Farlow Herbarium at Harvard University, has been elected a corresponding member of the Bavarian Academy of Sciences in Munich.

M. Achard, professor of clinical medicine at Paris, and Dr. Rohmer, professor of pediatrics at Strasbourg, have been elected foreign corresponding members of the Belgian Royal Academy of Medicine.

Mr. Vernon Bailey, of the U. S. Biological Survey, was one of eight honored at the first presentation of the award of The Silver Beaver of the Boy Scouts of America, consisting of diploma and medal for "distinguished service to boyhood," conferred by the organization's national council upon the recommendation of the District of Columbia executive board. The citation was "Mr. Bailey, senior biologist of the U. S. Biological Survey, became a scoutmaster in 1912 and has continued with the scout movement in various leadership capacities ever since. He has made a large contribution to scouting, developing interest in biology through the troop and camp museum, in nature understanding and outdoor lore."

The New York Endocrinological Society was organized by a group of physicians at the Town Hall Club, New York City, on January 29, and had its second meeting, February 26, at the same place. The following officers were elected: Dr. Walter Timme, *president;* Dr. Freeman Ward, *vice-president,* and Dr. Louis Berman, *secretary-treasurer.*

At the annual general meeting of the British Association of Economic Biologists held on February 26, the following were elected officers and council for 1932: *President,* Dr. W. B. Brierley; *Vice-presidents,* Dr. W. R. Thompson, Mr. A. D. Cotton; *Honorary Treasurer,* Dr. J. Henderson Smith; *Honorary Editors,* Dr. W. B. Brierley, Mr. D. Ward Cutler; *Honorary Secretaries,* Professor J. W. Munro, Professor W. Brown; *Council,* Mr. W. Buddin, Mr. A. D. Cotton, Mr. C. T. Gimingham, Mr. K. St. J. Cartwright, Mr. A. M. Massee, Dr. J. N. Oldham, Mr. R. C. Woodward, Dr. R. N. Chrystal, Dr. W. R. Thompson, Dr. M. A. Tincker, Dr. W. M. Ware and Mr. E. R. Speyer.

Dr. John J. Kindred, a specialist in mental diseases and formerly for ten years member of the U. S. House of Representatives, has been appointed professor of medical jurisprudence in the law department of Stetson University, DeLand, Florida.

Dr. Hermann Rein, professor of physiology in the University of Freiburg in Breisgau, has been called to Göttingen.

The Council of the University of Melbourne has passed a resolution expressing to Mr. F. Chapman, Commonwealth paleontologist, on his retirement from the position of part-time lecturer in paleontology after twelve years' service, its thanks for the help which by his wide knowledge and great experience of paleontology he has rendered to the geological department of the university.

Mr. William H. White has been appointed leader of the division of truck-crop and garden insects in the Bureau of Entomology. He had been acting in charge of the division since Mr. J. E. Graf resigned in March, 1931, to become associate director of the U. S. National Museum. Mr. White has been associated with the bureau for more than fourteen years.

Mr. Inman F. Eldredge, for sixteen years in the Forest Service and for the last six years forest manager of a 200,000 acre private forest property in southeastern Georgia, on which he has been developing intensive forest management, has been appointed by the Forest Service director of the forest survey in the south, which is part of a nation-wide survey.

Mr. D. J. Mahony has been appointed director of the National Museum, Melbourne, Australia, in succession to James A. Kershaw, who retired last year.

Mr. Emanuel Fritz, associate professor of forestry, University of California, has been reelected editor-in-chief of the *Journal of Forestry,* the official organ of the Society of American Foresters.

The Sixth International Botanical Congress will be held at Amsterdam from September 9 to 14, 1935. An executive committee has been formed, the president of which is Professor Dr. F. A. F. C. Went (Utrecht), while Professor Dr. J. C. Schoute (Groningen) will act as vice-president, Dr. W. C. de Leeuw (Bilthoven) as treasurer and Dr. M. J. Sirks (Wageningen) as secretary.

Dr. Samuel H. Williams, professor of zoology at the University of Pittsburgh, has been appointed a member of the Pennsylvania State Game Commission by Governor Pinchot.

SIR ROY LISTER ROBINSON, technical commissioner in the British Forestry Commission, has been appointed chairman of the commission, to succeed Sir John Stirling-Maxwell, who will retire this month.

THE Massey Scientific Research Fellowship of the value of £400 per annum, recently established at University College, Nottingham, for the purpose of promoting research on cancer by physical and chemical methods, has been awarded to Mr. L. A. Woodward.

IN addition to the grants recorded in SCIENCE last week the Committee on Scientific Research of the American Medical Association has given a grant to Dr. D. W. Bronk, professor of biophysics in the School of Medicine, University of Pennsylvania, to aid him in his work on the nervous regulation of the circulation. Dr. Solomon Rosokoff with Wilson D. Langley, of the department of biological chemistry of the Medical School of the University of Buffalo, have received a grant to be used for the study of ketosis in the white rat.

DR. JOHN T. GAMBLE, professor of biology at Thiel College, has been selected as visiting professor of zoology at the University of Pittsburgh Lake Laboratory for the summer of 1932. Dr. Gamble takes the place of Professor Samuel H. Williams, associate director of the Lake Laboratory, who has been granted leave of absence.

PROFESSOR GEORGE C. EMBODY, professor of entomology in the New York State College of Agriculture at Cornell University, has left on a mission to California to study the problem of replenishing the game fisheries of that state in conference with Dr. J. O. Snyder, formerly of Stanford University, and Mr. John R. Farley, of the California Fish and Game Commission.

DR. ESMOND R. LONG, professor of pathology, University of Chicago, delivered the annual lectures in pathology at the Ohio State University College of Medicine, on February 26. The first lecture was given before the faculty and student body on "A Survey of the Origins of Modern Pathology" and the second to the faculty, the students and the medical profession of Columbus on "The Exudative Phenomena in Tuberculosis."

DR. FREDERICK H. GETMAN, of Stamford, Connecticut, lectured on the Joseph H. Johnson Foundation at Pomona College, Claremont, California, during the month of February, giving five lectures on "Electrode Potentials" and two lectures on "Color Photography."

DR. A. F. BLAKESLEE, of the department of genetics of the Carnegie Institution of Washington, lectured on February 16 before the students of the science departments of Barnard College on "Taste Worlds We Live In."

DR. CARL J. WIGGERS, head of the department of physiology of the School of Medicine of Western Reserve University, Cleveland, sailed from New York, March 10, by way of Panama Canal, for San Francisco, where he will address the meeting of the American College of Physicians on April 6. His subject will be "Arterial Sclerosis and Hypertension."

THE forty-fourth annual meeting of the American Physiological Society will be held at the University of Pennsylvania from April 27 to 30. The first scientific session will be held on the morning of April 28, the previous day being devoted to informal meetings, council meetings and visits to the various medical schools and public institutions.

THE American Society of Agronomy and the American Society of Plant Physiologists will hold a joint meeting on July 11, 12 and 13 at the Wisconsin College of Agriculture.

THE centenary meeting of the British Medical Association, under the presidency of Dr. William George Willoughby, of Eastbourne, will be held in London, beginning with the annual representative meeting on July 21. The annual general meeting will be held on July 25, and the incoming president, Lord Dawson of Penn, will give his inaugural address on July 26. The scientific sessions will be held from July 27 to 29. The centenary dinner of the association will take place July 28. There is to be a pilgrimage to Worcester on Sunday, July 24, to unveil memorials to Sir Charles Hastings, founder of the association.

THE Woman's Medical College of Pennsylvania held an open scientific meeting at the college building, March 11, marking the eighty-second anniversary of its founding. Dr. Edward B. Meigs, Washington, D. C., was the speaker of the evening on "The Nutritive Value of Milk."

THE Society of Chemical Industry has formed a food group among the members of the society. For the present, at least, there is no additional subscription beyond the usual dues for membership in the society. Further information will be furnished on request to Foster D. Snell, honorary secretary of the American Section, 130 Clinton Street, Brooklyn, New York.

Nature reports that in view of the present situation, and the recent appointment of Dr. C. P. Blacker as general secretary of the Eugenics Society, the salaried appointment of Mrs. C. B. S. Hodson will terminate next August. Mrs. Hodson is to continue to work in close association with the society as a member of the council, and so secure the continuation of the eugenic work already begun in different parts of Great Britain. This arrangement leaves unaffected Mrs. Hodson's position as honorary administrative secretary to the International Federation of Eugenic Organizations.

THE lighting research laboratory of the General Electric Company and the department of research in physiological optics of the Dartmouth Medical School were awarded gold medals on March 8 by the Distinguished Service Foundation of Optometry for separate outstanding achievements in eye research. Dr. Karl Compton, president of the Massachusetts Institute of Technology, presented the medals on behalf of the foundation. The awards were made as a part of the convention of the New England Council of Optometrists. Investigations by Dr. M. Luckiesh, director of the Nela Research Laboratory at Cleveland, and his colleague, Frank K. Moss, related to the part proper illumination plays in conserving human eyesight and resulted in the creation of a new science of seeing, a combination of lighting and optics scientifically applied. The Dartmouth department was awarded a medal for its discovery of a hitherto unrecognized type of eye defect, due to small differences in the size and shape of ocular images, and the development of apparatus and lenses to detect and remedy such defect. The previously unrecognized type of eye defect was found to be an unsuspected cause of headaches, eye strain and various systemic disturbances not relieved by any retractive correction.

THE Storrow Fellowships, under the division of geology and geography of the National Research Council, are to be continued during the coming year through a personal gift of funds to Mr. Arthur Keith. The fellowships are intended primarily to assist students of promise in fitting themselves for a career of research in geology or geography, and particularly in the later stages of their preparation which might otherwise be beyond their reach. Applications for fellowships should be addressed to Mr. Arthur Keith, U. S. Geological Survey, Washington, D. C., who is chairman of the fellowship committee, and should reach him on or before the end of March. Letters in support of an application should also be furnished by persons who are acquainted with the character, record or plans of the applicant.

THE main laboratory of the Dominion Biological Station was destroyed by fire of undetermined origin on March 9. Valuable equipment and records were housed in the laboratory, which was located in Brandy Cove, near Joe's Point, a considerable distance from the main section of St. Andrews. Its value was estimated at $80,000.

ACCORDING to an Associated Press dispatch the Senate moved on March 10 to pave the way for acceptance of a $4,000,000 gift from Mr. John D. Rockefeller, Jr., for roads in the Acadia National Park in Maine by adding to the Interior Department appropriation bill $250,000 for moving the Otter Cliffs Naval Radio Station, which now blocks the route. The amendment was sponsored by Senator Porter Hale, Republican, of Maine, who announced that Mr. Rockefeller had offered the sum.

SCIENCE SERVICE reports that Delegate to Congress, Victor Houston, of Hawaii, has called attention to the fact that a reduction of $11,000 in the appropriation for the volcanology work in Hawaii and Alaska in the Geological Survey of the Interior Department will mean the dismissal of an associate topographic and geodetic engineer and an assistant geologist, who were added to the pay roll in 1932, also two local observers or field assistants in Alaska who look after the seismographs there. T. A. Jaggar, volcanologist in charge of the work in these two outposts of the United States, wrote that the increase of funds in 1932 from $21,000 to $32,000, allowed a complete reorganization of both the work and the staff, so that now "five higher officers are resident here (Hawaii), four with their own homes, and the janitor and mechanic in addition." Under present plans, two of these higher officers will have to give up their jobs.

ONE of the first shells that fell in Shanghai destroyed maps and charts compiled by Dr. George B. Cressey, professor of geology at Syracuse University, who spent seven years and traveled 30,000 miles in Manchuria and in twenty-four of the twenty-eight provinces of China, gathering material for a geological survey. The documents were stored in the building of the Commercial Press.

THE directors of the Textile Foundation, Washington, D. C., recently made an allocation of $100,000 to be spent during the course of the next two years for fellowships and scholarships in scientific research for the benefit of the textile industries. These fellowships are: Senior fellowships. For those who hold a doctorate degree or who have had equivalent training. The normal stipend is, unmarried, first appointment, $2,000; reappointment, $2,200. Married, first appointment, $2,400; reappointment, $2,700. Junior fellowships. For those who hold a bachelor's degree or who have had equivalent training. The normal stipend is, unmarried, $1,000; married, $1,200. Scholarships. Available to seniors in good standing. The normal stipend is $750. In addition to the stipend, customary tuition and laboratory fees will be paid by the foundation. Conditional upon satisfactory service, the term of the senior or junior fellowship is for twelve months subject to renewal. Thirty days vacation will be allowed. Conditional upon satisfactory service, the term of the scholarship is for the academic year. All communications should be addressed to Edward T. Pickard, Secretary, The Textile Foundation, Commerce Building, Washington, D. C.

THE State University of New Jersey, now operated in conjunction with Rutgers College, at New Brunswick, is the ultimate beneficiary of the bulk of a $128,000 estate left by Edward Randolph Wood, lawyer and business man, who died on February 14 in his ninety-second year. Mrs. Wood receives the income from the estate during her lifetime. Mr. Wood suggested that it be devoted "to the study of the elimination and destruction of animal and vegetable pests." Red Oaks, the Wood summer home at Richland, N. J., near Vineland, is to be held "as a residential, social and educational center or home" for officers, faculty members, students or others connected with the university.

THE annual exhibition of current developments and activities in the field of mechanical and electrical engineering given jointly by the Yale Branch of the American Institute of Electrical Engineers and the Yale Branch of the American Society of Mechanical Engineers was held on March 7. The exhibition, staged entirely by students in the Sheffield Scientific School, gave a comprehensive survey of the part played by the mechanical and electrical engineer in modern civilization. Many of the exhibits were so arranged that the internal operation of the apparatus could be seen. The use and working principle of new machinery was explained by students; public utilities, such as a gas manufacturing plant, was shown working in miniature. Various movements in the development of machinery was illustrated by models; industrial and remote control systems were in operation in various parts of the exposition demonstrating their uses and conveniences. All the exhibits were in operation.

THE will of the late Dr. William H. Nichols has been appraised, and it is announced that half the residuary estate (less certain legacies) bequeathed to New York University, amounts to $3,670,401. Other bequests, amounting to $795,000, include $250,000 to the Polytechnic Institute, Brooklyn, and $50,000 to the American Chemical Society.

DISCUSSION

THE CONTROL OF INJURIOUS ANIMALS

UNDER the caption "The Control of Predatory Mammals," Mr. H. E. Anthony[1] expresses strong disapproval of the injurious-animal control activities of the Biological Survey, U. S. Department of Agriculture. He refers to organized propaganda carried on for several years by a small group, obviously seeking to discredit and obstruct the work.

Some of the opponents of the injurious-animal control policy of the survey are men of high attainment in their professions. Their sincerity and motives are beyond question. Most amazing to me, therefore, has been the apparent willingness of men, who I supposed were trained in the application of the scientific method, to accept as factual evidence misleading half truths and irresponsible criticisms. The attack, with its emotional appeal, is based mainly upon misdirected sentiment and distorted concepts of wild life in relation to human welfare. Its unscientific basis is shown by the absence of evidence that the value of injurious-animal control has been given any serious consideration by the opposition.

Mr. Anthony mentions the appointment by the American Society of Mammalogists at the New York meeting of May, 1930, of a committee, of which he is chairman, on the problems of predatory-animal control, instructed, he states, "to attempt a critical investigation of actual conditions in the field." The report of the committee as read by him at the Philadelphia meeting of May, 1931, consists of sweeping denunciation of the predatory-animal control work of the survey, without presenting any definite evidence obtained either by members of the committee or by its field investigators upon which such drastic conclusions could properly be based. There was an exchange of field reports, and since Anthony has used parts of survey reports that suited his purpose, it is only fair to quote from that of the only committee member who undertook extensive field studies.

Dr. C. T. Vorhies, an experienced field naturalist of the University of Arizona, designated to study field conditions in Arizona, New Mexico and Texas, approached the subject in a scientific spirit and submitted a report of 140 pages, embracing a fair review of the situation. His report was mildly critical of some features of the survey's control work and highly commendatory of others. He says:

> . . . after my own enlightening experience of the past several weeks, I may say frankly that I sincerely wish that all other members might have had the opportunity I have had for field observation *in this particular line* [italics his]. After more than twenty years in the West, and a considerable experience in the field, this was an eye opener for me! One's personal insight into the whole of the problem is so enlarged (perhaps modified)

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[1] SCIENCE, 74: pp. 288–290, Sept. 18, 1931.

> that I suspect that other members of the Committee will find difficulty in understanding my views and report. For example, one may readily believe from merely reading the reports of the large numbers of animals killed by the Survey that extermination of certain forms will soon result. But weeks of travel over this territory, observation of its great extent compared with the small areas actually worked at any one time or in any one year, and of the actual presence of a plentiful supply of these animals is not only enlightening but reassuring. I am deeply concerned that this committee shall not too readily accept and adopt irresponsible criticisms as their own, through lack of pertinent information, or through lack of actual contact with field conditions of this problem.

Other passages from the report of Vorhies show broad grasp of the practical considerations involved and are favorable to the survey, but are ignored by the committee's report.

Passing from predatory animals to injurious rodents, Mr. Anthony reechoes the criticism of others of the use of thallium as a poison based on statements by Dr. Jean M. Linsdale, in *The Condor*.[2] Special Publication No. 109, "The California Ground Squirrel Control Program," issued late in 1931 by the California State Department of Agriculture, presents the other side of the thallium situation and the results of an investigation of Linsdale's "cases." The cases seem to consist largely of unverified reports, which, accepted as facts, prove on investigation to be largely misrepresentations that led to sweeping and erroneous conclusions. According to the state publication, some of the alleged "cases" of thallium poisoning are from areas in which no thallium has ever been used.

Dr. Joseph Grinnell, in an editorial in the same number of *The Condor* (pp. 131–132), indorses Linsdale's "findings," and adds some speculations of his own. The publication of the California Department of Agriculture (*op. cit.*, p. 18) refers to Grinnell's editorial and comments as follows:

> It carries the implication that one third of the area of California is being repeatedly poisoned with thallium, when as a matter of fact, a survey recently completed by the State Department of Agriculture shows that less than 5 per cent of the area of California has ever been treated with thallium grain. . . . The supplementary use of thallium is largely rendering retreatment unnecessary and remarkably reducing the amount of poison used on definite areas.

Assuming the rôle of a statistician, Grinnell indulges in a process of calculation too devious for me to follow, when, apparently multiplying dead animals found by 10,000, he says: "We can figure from this that in the last four years not less than 50 *million* animals *other than* ground squirrels [italics his] have been killed in California through these operations!" One of the conclusions reached by the state publication (*op. cit.*, p. 20) is that "The *Condor* article and editorial, designed to arouse bird lovers, conservationists and the general public against the continuance of necessary pest control work, is replete with misleading information and contains few 'facts concerning the use of thallium.'"

Bubonic plague in California ground squirrels, occasionally assuming the pneumonic form, has become endemic in 14 counties in California. Human cases occur at intervals and new foci of infection are found by the Public Health Service from time to time. In the great plague epidemics of the past, the rat carriers apparently became immune, as the disease receded, after sweeping periodically across Europe, to its original home in Asia. In California, however, it is established in a group of ground squirrels (*Citellus*) of wide distribution, which with our prairie dogs (*Cynomys*) and woodchucks (*Marmota*) are closely allied to Asiatic rodents believed to be natural enzootic hosts. This alone is a sinister phase of the California situation that is ignored by propagandists against the use of thallium, a poison that, after many years of experiments, has afforded the only practicable method of controlling these animals.

The need for control of ground squirrels in California has been well set forth by the same Dr. Grinnell, who now inveighs against the use of poison.[3] Passages relating to the California ground squirrel are quoted (beginning p. 604) as follows:

> A few years ago it came into prominence as a proven disseminator of the dreaded bubonic plague, and it has become notorious for its exceeding destructiveness to cultivated crops.

Then on page 706:

> Ground squirrels breed upon cultivated or waste land, from which they invade the cultivated fields within reach as well as such other lands as are not already fully populated.

On page 704:

> On open range and pasture lands these squirrels feed largely on alfilaria and bur clover, two of the most valuable forage plants in the state. The squirrels are then serious competitors for subsistence against the flocks and herds upon which man depends for his own support. On cultivated ground these squirrels feed upon or destroy in other ways grain and fruit crops to a very large extent where present even in numbers not above those reached on wild land. *The tendency seems to be to increase to*

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[2] Vol. 33, no. 3, pp. 92–106, May–June, 1931.

[3] "California Ground Squirrels," by Grinnell and Dixon, Monthly Bulletin, California State Commission of Horticulture, vol. 7, pp. 597–708, Nov.–Dec., 1918.

> *extraordinary numbers on cultivated lands unless effectively checked by man.* [Italics mine.]

And finally, page 707:

> It is hoped the facts and inferences set forth will convince the reader that the problem is not a simple one [referring to ground squirrels], and can not be solved by casual, half-hearted measures.

Contrast the foregoing with some of Grinnell's *Condor* editorial expressions (*op. cit.*), as:

> There is a certain administrative type of mind to which the human "use" of all natural resources and the correlated elimination of anything which looks to be detrimental, or even not immediately and clearly of value, loom as the only "practical" aims.

And:

> In our mind, at the present moment, the wholesale poisoning of wild animal life (birds, carnivorous mammals, rodents) on uncultivated terrain, ought to cease; not only that, but it should be prohibited by law.

In 1918 Grinnell pointed to ground squirrels on uncultivated land as a source of invasion of cultivated fields, and now he would prohibit poisoning them there by law. In such a view, obviously, not only the public health but economic considerations are to be entirely ignored.

The principal organizer of the campaign against effective injurious-animal control operations appears to be Mr. A. Brazier Howell, whose wide-spread propaganda and narrow view-point, plausibly presented, have undoubtedly misled many. An example of his methods in arousing prejudice against the work is his assertion, founded on the fact that certain carnivores and rodents eat grasshoppers, that he can predict outbreaks of these insects by the course of injurious-animal control operations.

Mr. Howell[4] elaborates on theories that seem to be based on his lack of understanding of wild-life conditions and the use of poison. He says:

> I venture to state that it is universally believed by biologists that as rodents are now being virtually exterminated over large areas by means of poison, their places will be taken by other, and possibly more destructive, forms of life. . . . Under modern methods of poisoning, the mortality of rodents may approach 100 per cent. . . . On the surface, then, it seems that all rodents and all carnivores are gone, and everything should be lovely.

These quotations and the context show that Howell bases his absurd grasshopper predictions and other contentions on the theory that the injurious-animal control work nearly exterminates all rodents and carnivores. He has elsewhere referred to the "broadcasting of poison bait," apparently assuming that poison for rodents, at least, is regularly distributed in that way instead, as is really the case, of being placed at the holes where it is known to be consumed mainly by the animals for which intended. Many acres of unpoisoned ground, well populated by rodents of many kinds, commonly separate the holes of the injurious species where poison is placed. Any scientific investigation will reveal that the general rodent population is little disturbed by such poison operations. Upon such erroneous and misleading premises Howell bases his case against effective control of injurious species, and asks the country to accept his conclusions.

For those who do not have to bear the burden of responsibility in the solution of wild-life problems, often almost baffling in their complexity, it is easy to criticize. Some criticism must be expected and some may be deserved, but when criticism comes from professional zoologists it should be fair and made only with broad knowledge tempered with appreciation of all the difficulties that may be involved. Charges of any kind should be based upon definite scientific evidence, and such evidence has been singularly lacking throughout the obstructive campaign in progress. In my judgment one of the greatest handicaps to the real conservation of wild life in America to-day is the lack of harmony and concerted effort that results when individuals or groups who may be sincere, but misinformed and misguided, becloud issues and adopt a captious and dictatorial attitude toward those charged with carrying on wild-life administrative work.

E. A. GOLDMAN

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THE GASTRIC EROSION OF METAL

DR. C. T. HURST, who recently[1] reported a case of gastric erosion of a fishhook swallowed by a fish, concluded that it may have taken about a year to reduce the former metal to a mere filament. A rapid gastric erosion of pieces of steel, iron or aluminum was sometimes observed in rabbits and guinea-pigs during a study of the rate of passage of inert materials through the digestive tract,[2] but the precise amount of metal dissolved was not then determined. At present, in an attempt to analyze the mechanism of the production of peptic ulcers in rats by diets low in protein,[3] a study is in progress in which the amount of metal dissolved (weight lost) is being determined in the belief that it serves as an index of gastric acidity. The results obtained thus far mainly tend to emphasize the relation between the length of stay of the metal in the digestive tract and the degree of erosion. Thus, 100 small pieces of aluminum, which generally pass out of the stomach rapidly, have been given from time to time to rats without showing any loss in weight. Pieces of iron and steel, which remain longer in the stomach than aluminum, lost from about 0.1 per cent. (average of 200—1/16 inch stainless steel ball-bearings) to over 5.0 per cent. (average of 100 pieces of No. 18 gauge soft iron rod). Those pieces of iron and steel that remained longest in the stomach (up to 10 days) obviously lost much more weight than the average. A factor that also enters here is that, after the metal has been roughened by the initial erosion, further erosion proceeds at a faster rate. In one rat that was given a large amount of gold and silver in addition to some aluminum, a few pieces of aluminum rod (No. 20 gauge) remained about 3 days in the stomach and were eroded to the breaking point. At the usual gastric acidity of 0.5 per cent., or less, of HCl, aluminum resists erosion more than some kinds of steel and much more than soft iron. Hence, one might expect a fishhook to erode quite completely in a few weeks. Either these observations on mammals are not applicable to fish or Dr. Hurst's allowance of a year's time makes his report a typical fish story.[4]

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[4] SCIENCE, vol. 74, p. 632, Dec. 18, 1931.

[1] SCIENCE, Nov. 20.

[2] F. Hoelzel, *Amer. Jour. Physiol.*, 92, 466, 1930.

[3] F. Hoelzel and Esther Da Costa, *Proc. Soc. Exper. Biol. and Med.*, 29, 382, 1932.

FREDERICK HOELZEL

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POLYDACTYLISM IN MICE

IN a strain of mice which carried factors for posterior duplication Danforth, in the *American Journal of Anatomy,* v. 45, 2, 1930, recorded the occurrence of extra toes on a number of animals. His investigations did not show any indication that the factor which governed the polydactylous manifestations was in any way distinct from that which governed the more pronounced effects (double feet, double legs and finally double posterior halves of the body). Rebaud, in Paris, 1919, reported polydactylous animals in a stock of mice which had an abnormal luxation of the posterior feet. The manner of the inheritance was not determined.

From a study of the literature which deals with visible characters in mice these are the only reports which have come to my attention that record the inheritance of polydactylism in stocks other than those which had been previously subjected to experimental treatment with roentgen rays.

Within the last few months polydactylism has expressed itself in a six-toed condition of the posterior feet in thirty-seven animals of a highly inbred strain of control mice in these laboratories.

The strain from which the polydactylism has arisen, as reported in SCIENCE (1931, 73, p. 482), recently underwent a mutation in hair color from chocolate brown to "leaden." At the time of the color mutation only one six-toed animal had ever been observed in the stock. This polydactylous individual was in the direct line with that of the color mutation but left no polydactylous progeny.

Among animals of the last few generations, however, the polydactylism has occurred eight times in the original stock mice, twenty-three times in pure stock mutants, and six times in the progeny from outcrosses between mutants and four unrelated strains in which the six-toed character has never been observed.

Polydactylism has been studied rather extensively in humans, guinea-pigs and poultry, and from these observations the condition is regarded as being inherited as a dominant character, expression of the character being controlled by certain unknown modifying factors. This nucleus of inbred mice offers a new species on which to investigate the method of inheritance of the character. From the preliminary matings between polydactylous mice it has already been shown that the six-toed condition does not breed as a simple recessive.

JOSEPH M. MURRAY

ROSCOE B. JACKSON MEMORIAL
LABORATORY,
BAR HARBOR, MAINE

TOXICITY OF SODIUM NITRATE FOR A SPECIES OF MOSS

IN an extensive series of experiments in Hampshire and Worcester Counties, Massachusetts, in which upland permanent pastures were top-dressed with Chilean sodium nitrate and other fertilizer materials, it was observed in 1929 and further confirmed in 1930 and 1931 that the nitrate was toxic to *Polytrichum commune,* a species of moss. This moss is common on "run-out" upland pastures of the New England states, the amount of moss present apparently being inversely proportional to the amount of available plant nutrients in the soil. The nitrate was used in amounts equivalent to 30, 60 and 90 pounds of nitrogen per acre. Toxicity was not as severe with 30 pounds of nitrogen in the form of nitrate as it was with 60 and 90 pounds. No definite evidence of direct toxicity from the use of limestone, hydrated lime, 16 per cent. superphosphate or muriate of potash was observed in 1930.

In 1931 a new experiment was begun in which were used the following materials: (1) Chilean nitrate of soda; (2) Arcadian nitrate of soda; (3) calcium nitrate; (4) by-product ammonium sulfate; (5) calcium cyanamid; (6) urea; (7) potassium nitrate; (8) potassium chloride; (9) sodium chloride. These materials were applied to an area infested with *Polytrichum commune* at the rate of 30 and 60 pounds of nitrogen per acre in case of the nitrogen carriers, and the chlorides were used in chemically equivalent amounts. Application was in the spring. Observations made at the close of the season showed the highest degree of toxicity from sodium and potassium nitrates used in the higher amounts, followed by the sodium and potassium chlorides in chemically equivalent amounts and by sodium and potassium nitrates at the smaller rates. The other nitrogen carriers, including calcium nitrate, showed no toxic effects.

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[4] M. Dobreff, *Pflüger's Archiv,* 217, 221, 1927, reports the finding of as high as 0.69 per cent. free HCl in the stomach of sharks.

From observations thus far made it appears that toxicity of certain nitrates for this species of moss seems to be due primarily to the sodium and potassium ions. However, the cationic effect seems to be linked somewhat with the anionic effect, for, with one exception the nitrates were more toxic than the corresponding chlorides. This observed toxicity is not an indirect effect, that is, a crowding out of moss by other vegetation, as was first supposed, but is an actual killing of the moss. The effect is immediate and in proportion to the amount of sodium nitrate applied. It is also cumulative, so that after several smaller applications the effect is similar to that of a single larger application.

A. B. BEAUMONT

MASSACHUSETTS AGRICULTURAL
EXPERIMENT STATION

PREHISTORIC MOUNDS IN SOUTH FLORIDA

SEVERAL professors connected with the University of Miami have been working on a mound recently discovered on Key Largo which is suspiciously Mayan in character. It is a stone structure carefully constructed by aboriginal masons and is strikingly like several structures in British Honduras. The character of the pottery found in the neighborhood indicates a foreign origin, since there is no pottery clay in Southern Florida. It is black and hard like the pottery of Yucatan. Obsidian knives and other remains discovered in the vicinity of the mound are also indicative of foreign influences. Various canals and small harbors dug in this region indicate that Southwestern Florida was once inhabited by a numerous and enterprising population. The Mayans were great seamen and traders and it is more than likely that they settled in Florida. The abundance of game, especially fish and shell-fish, would have been a great attraction. There is reason for believing that the Calusas were of Mayan stock and that even the Seminole may have Calusa blood in his veins. This region will be included in the proposed National Everglades Park and it is hoped the Seminoles may be used for guards and guides.

The University of Miami, under whose auspices the preliminary researches have been made, will continue its investigations in this region and will later publish fully the results of its studies.

JOHN C. GIFFORD
ALFRED H. GILBERT

CORAL GABLES, FLORIDA

SCIENTIFIC BOOKS

Comité national français de Géodésie et Géophysique. Assemblée générale du 9 mai 1931. Au Secrétariat général du Comité. Rue d'Anjou, 78, Paris 8e.

THIS publication gives the proceedings of the 1931 annual meeting of the French National Committee on Geodesy and Geophysics. These proceedings cover only some nine pages. The remainder of the volume of over 90 pages is occupied with reports of the sections dealing with the various special branches of geophysics and with membership lists. The reports themselves are summaries, or sometimes summaries of summaries, so it would be rather absurd to carry the process of summarization still farther in this review. The reviewer will therefore confine himself to making a few general remarks, based on this publication as a text, and to mentioning a few of the items found merely because they happen to be connected with fields of work in which he is especially interested or to strike his fancy as odd or noteworthy. A different reviewer would no doubt find texts for different sermons and would single out different items for special mention.

It is instructive to read publications of this sort. They bring before the reader the great diversity and the wide ramifications of geophysics and, in spite of these, its essential unity. The subjects treated in the different sectional reports vary greatly, but the membership of the sections overlaps extensively (just as it does in the case of the American Geophysical Union), and everywhere problems are encountered that concern more than one section. Geophysics extends on one side into geology and geography, on the other sides into technical physics and astronomy. If any one is to be immune from the dangers of too narrow specialization, the geophysicist ought to be.

The meeting of the French National Committee looked both to the immediate past and the near future.

Much space was given in all sectional reports to the meeting of the International Geodetic and Geophysical Union that had been held at Stockholm the year before; and much space also, especially in some sectional reports, to the plans for the International Polar year of 1932–33.

It is interesting—at least to a geodesist—to note that the French section of geodesy has the largest membership of all the sections (nearly the reverse is true of the American Geophysical Union). Not all the members of the section are professional geodesists. Perhaps the explanation is that the place of geodesy in general geophysics is something like that of anatomy in the medical sciences; that is, geodesy like anatomy, is a fundamental subject, some knowledge of which is required by the specialist in other subjects.

In the Section of Geodesy considerable attention was paid to gravity at sea. It was hoped that Dr. F. A. Vening Meinesz, of Holland, who has perfected a method for obtaining accurate values of gravity at sea by means of a specially constructed apparatus used aboard an immersed submarine, would be admitted to a French submarine to take observations and to train others in the art. At the last moment, however, these plans had to be cancelled because of objection on the part of the Naval General Staff. It may be added, however, that since the date of the meeting here reported, the work of obtaining gravity at sea has made notable progress. Many observations of gravity over the Mediterranean have been made with Meinesz's apparatus in an Italian submarine; Meinesz himself is at this writing (February, 1932) engaged in his second gravimetric campaign in an American submarine operating among the West Indies and the Bahamas; and only Meinesz's departure for the United States to take part in this campaign prevented his acting as instructor to a French hydrographer and a French naval officer who were to be sent to Holland to be trained by him. It is therefore to be supposed that eventually the French navy will participate in this important work.

Mr. Holweck and Father Lejay have developed an apparatus for the rapid determination of gravity, of which great things are hoped. In principle it is a metallic strip clamped to point upward and to execute elastic vibrations. The vibrations are greatly slowed down by means of a load applied to the strip. The slowing down varies with the intensity of gravity, hence the period of vibration under the combined effects of the elasticity and of the load may be used to determine relative gravity. The crucial question is: will the elastic properties of the metal remain sufficiently constant with age and use?

The Section of Seismology reports plans for a first-class earthquake observatory at Martinique. More observatories like this are needed in this unstable region and its nearness to Mont Pelé will add to its value. The Union of Socialist Soviet Republics in its Stockholm report tells of very extensive plans for seismological study. If fully carried out, they will add much to our knowledge.

One more item in the report of the Section of Seismology deserves mention, though it is of a quite different order of magnitude, so to speak, from the comprehensive plans of the Soviet Government. At Le Mans (in Maine, France, not Maine, U. S. A.) there was a seismological station maintained by the energies of one man and the support of the community. This one man, Mr. Jagot, did an excellent work not only in maintaining the station but in arousing popular interest in the subject and in spreading a knowledge of it. Now, being 77 years old, he feels compelled to retire. It would be a fine thing if competent amateurs in science were everywhere more numerous and were also interested in spreading a knowledge of science. Seismological institutions also might well consider whether they should not give more attention to popularizing their subject.

The Section of Seismology also reports that for lack of radio apparatus many French seismological stations are unable to take advantage of the seismological broadcasts sent out from time to time from the U. S. Naval Station at Arlington along with the daily weather forecast. By way of explanation it may be added that these messages result from international cooperation and from the collaboration of stations in the United States, Canada and the Pacific area, of the Coast and Geodetic Survey, of the Jesuit Seismological Association and of Science Service.

The report of the Section of Oceanography mentions the possibility of adapting the Favé tide-gauge, which is a pressure gauge for use at sea, to the study of surface waves, adding that experimental work on these short-period surface waves is much needed. The report also mentions the formation of an international committee to study the so-called (and miscalled) tidal waves (in French "raz de marée)." Presumably these "tidal waves" are solitary waves or small groups of waves caused by submarine earthquakes. Some less misleading term than "tidal wave" is needed and the noncommittal Japanese word *tsunami* has been suggested but has so far found no general acceptance. (This comment on nomenclature is the reviewer's, not the report's). In the report of the same section are some interesting remarks on the fallibility of water temperatures as an indication of the nearness of icebergs.

The Section of Hydrology reports a test made to check the operations of a magician, presumably—from the context—a finder of water by means of a divining rod. As was to be expected, the so-called magic was found to yield no results of value. The section is reported to be on the lookout for further tests of this sort in order to clear away superstition and increase real knowledge. This raises the question of the duty of scientific organizations when they encounter superstitious beliefs in their special fields. Should they sit back and do nothing, on the theory that a superstitious man is immune to reason and that attempts to argue him out of his superstition are pure waste of energy, or should every opportunity be sought not only to diffuse knowledge but also to combat superstition?

Two difficulties are more than once referred to that are familiar enough to geophysicists on this side of the Atlantic also. One is the difficulty in getting money for geophysical work; the other is the unwillingness of organizations engaged in commercial geophysical work to make their results public in order that general scientific knowledge may be advanced thereby.

The above are samples of the nuggets that may be found even by a hasty perusal of what at first glance would seem to be an exceedingly dry routine report.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A HOLDER FOR CHICKENS AND OTHER BIRDS

IN an effort to find a practical means for holding chickens without the aid of an assistant a board was designed which can be used for confining fowls quickly and firmly in either ventral, dorsal or lateral positions.

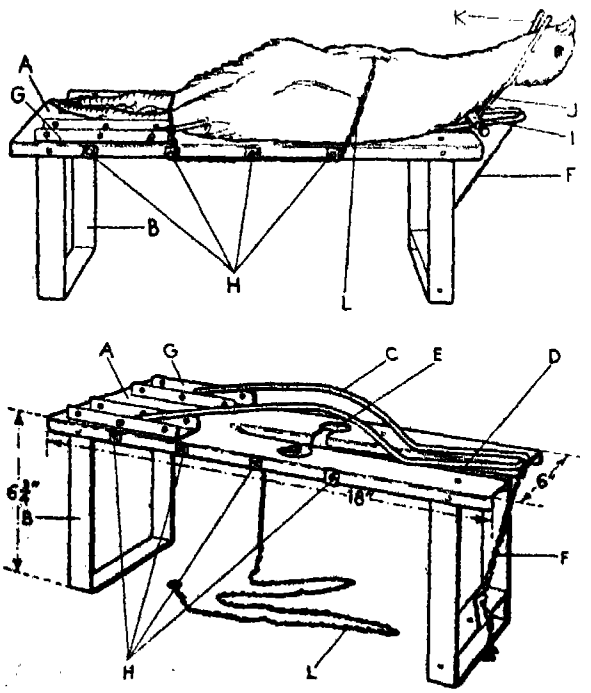
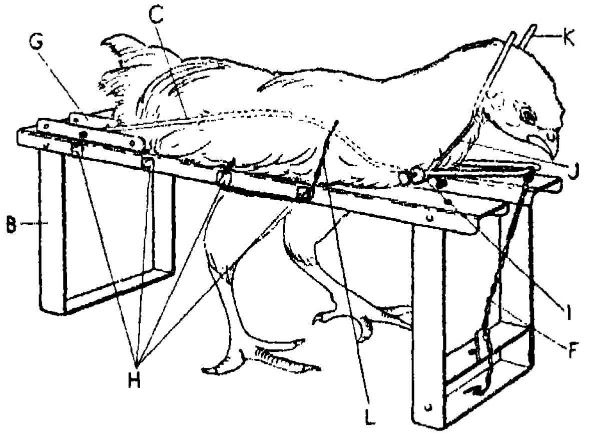


FIG. 1.



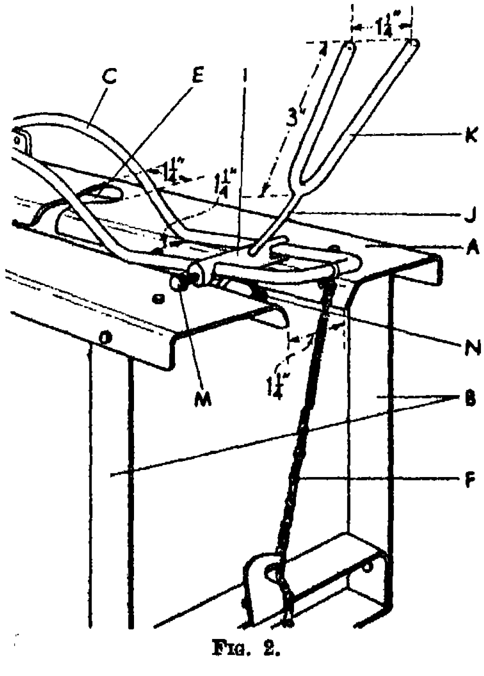


FIG. 2.

This board (Fig. 1) consists of a sheet of metal supported on legs to form a low table and a loop of metal, curved to conform somewhat to the shape of the chicken's body, hinged to one end (C). A long notch (D), 1¼″ across, cut lengthwise in the board with two circular perforations (E) located on either side and joined to it, provides a place for the legs and sternum when the chicken is in the ventral position, and for the vertebral column and ilium when in the dorsal position. The loop (C), which can be attached at various points (G) depending on the size of the chicken, fits over the body in either the dorsal or ventral position and holds it firmly against the board. It is fastened with the chain and spring (F). Another chain (L) holds the legs when a chicken is fixed in the dorsal position and may be used with the loop or alone for fastening the body to the board. It is particularly useful for restraining a chicken in either the dorsal or lateral position with the wings through the notch (D).

A detachable head holder (Fig. 2) in the form of a fork set at an angle of approximately 45 degrees to the parallel bars of the loop (C) may be easily adjusted by the set screws (M and N). By using this the head may be either raised well above the body or extended horizontally.

The board is especially useful for bleeding chickens from the carotid and wing vein. It can be used for operations, photography and for a variety of other laboratory procedures. It can be made by any worker in sheet metal, is easily sterilized and has few parts to get out of order. A larger size can be used for geese and turkeys.

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FREEZING TECHNIQUE FOR THE HISTOLOGICAL STUDY OF PIGMENTS IN AMPHIBIAN INTEGUMENT

IN a problem which is now in progress on pigmentation in Triturus it became necessary to make histological preparations. It was found that when the usual procedure of fixing, embedding and sectioning of tissue was pursued, the yellow and red pigment disappeared. This pigment, it was found, is very soluble in strong alcohols, cedar oil, aniline oil, xylol and strong formalin solutions. The frozen method of sectioning was then attempted. Trouble was encountered here. The skin is very thin and unless cut fairly thick (30 to 40 microns) would roll and wrinkle to such an extent during the process of washing and staining that the section would be made useless. This was remedied by placing the tissue in a weak solution of formalin for a half an hour to an hour. Too strong a solution of, or too long a time in formalin would cause the pigment to be dissolved. But a half hour in 10 per cent. formalin was sufficient and gave the desired rigidity to the tissue.

Other disturbing factors were that, first, when making sections in warm weather, the blade would melt the frozen block while cutting the tissue; and secondly, it was difficult to get the tissue off the blade before it melted. There was always great danger of damaging the tissue when taking it from the blade in the melted condition. These disturbing factors were remedied by our "ice dam."

The entire procedure for sectioning and staining is given below:

Place the fresh tissue in a 10 per cent. solution of formalin for half an hour to an hour.

Wash the tissue in water for an hour after taking it from formalin. Then place in a concentrated solution of dextrin for three to twelve hours.

Build on the microtome an "ice dam" of paraffin. This ice dam is made by warming some paraffin and shaping it into a long three-sided block. Place the base of the block on the blade and let the block extend almost the length of the blade. Curve the ends of the paraffin block over the edges of the upper portion of the blade in order that the dam may not slip. Make the dam high enough for the water from the melting ice to flow over the back of the knife. A few drops of dextrin solution on the inner edge will prevent water from running under the dam. Place small blocks of ice in the dam. Keep the cutting edge of the knife as dry as possible by continually blotting off the water of condensation.

To freeze the tissue: Place drops of concentrated dextrin solution on the freezing block of the microtome and open the valve very gradually to let the drops freeze slowly. Then place the tissue on the frozen drops and add dextrin slowly until the tissue is finally surrounded by a small block of sugar solution. The very best results are obtained when the valve is opened slightly. Not only is carbon dioxide wasted when the valve is opened so that a heavy blow of gas is obtained, but there is also the possibility of the tissue freezing too hard.

To obtain the maximum efficiency from the carbon dioxide, place the tank with the nozzle end at the level of the microtome and the base of the tank at least a foot higher than the nozzle level.

As soon as the tissue is frozen, begin sectioning. Hold the handle firmly in the right hand and pull the knife across the block quickly. With a camel's hair brush in the left hand, quickly remove the section from the knife before it melts. If the section melts, one is likely to damage the tissue in brushing it from the blade.

Place the section in a syracuse dish of Ringer's or physiological salt solution. When a sufficient number of sections have been made, they may be stained.

By means of a small glass rod, headed on the end like a balsam dropper, remove the section from the solution. Let the section wrap around the beaded portion; it has been hardened enough in formalin to hold its shape fairly well. The section may be held up slightly in the solution by means of a dissecting needle while the glass rod is being slipped under it. With the section remaining on the glass rod, dip it into the stain for ten seconds (the stain I found best for this tissue was polychrome methylene blue). From the stain place the section into Ringer's or physiological salt solution. It is all right to let the section drift in this solution, for the stain gives it added rigidity so that it may easily be picked up again with the rod.

Now, still by means of the glass rod, transfer the section to a slide on which is a drop of Brun's Glucose Medium. By rolling the rod through the drop of liquid the section can be made readily to come off of it. (Glycerine alone takes the stain from the tissue.) A cover slip may now be placed over the tissue. This must be done carefully, for the tissue is often wrinkled in the placing of the cover slip.

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SPECIAL ARTICLES

THE CULTIVATION OF A SPECIES OF TROGLODYTELLA, A LARGE CILIATE, FROM THE CHIMPANZEE

THE examination of several chimpanzees at this laboratory recently revealed that one was infected with a large ciliate of the genus *Troglodytella*. Reports of such an infection are not numerous and the organism seems to have been very little studied. Although this species has not been definitely determined it has been studied alive and stained and found to answer very closely the description of *T. brassarti* var. *accuminata* Reichenow.[2, 3] Attention was at once directed to it in the hope that it might be cultivated and be used for further studies.

At the time of the discovery, *Balantidia* from other individuals of the same group of chimpanzees were being cultivated. In this preliminary work the *Troglodytella* has been cultivated for a short time following the same technic that was used in the cultivation of the *Balantidia*. The medium which has proven to be most satisfactory in the writer's experience for the *Balantidia* has also given the most encouraging results for the *Troglodytella*. This medium is that of Tanabe and Chiba[4] for the cultivation of *E. histolytica*. Pig serum only has been used in these experiments.

Greatest success was obtained in an experiment in which six test tubes containing 10 cc of solution were inoculated with about 1 gram of fecal material containing *Troglodytella* and a few *Balantidia*. These tubes were incubated at 37.5° C. The results were as follows:

Tubes	Serum	24 hrs.	48	72	96	120	144	168	172
1	5 per cent.	+	+	+	+	+	+	+	−
2	5 ‘‘ ‘‘	+	+	+	+	+	+	+	−
3	5 ‘‘ ‘‘	+	+	+	−				
4	10 ‘‘ ‘‘	+	+	+	+	+	+	+	−
5	10 ‘‘ ‘‘	+	+	+	−				
6	10 ‘‘ ‘‘	+	+	+	−				

In 24 hours many very active *Troglodytella* and a few *Balantidia* could be seen swimming in all the tubes. Subcultures were made at this time from tube 4, which seemed to contain the most ciliates. In 48 hours the *Troglodytella* had apparently increased in numbers and a number of dividing individuals were seen at this time. The ciliates were very active and some could be seen boring into the agar slant. The *Balantidia* had also increased in numbers. At the end of 96 hours all ciliates in three tubes had died and in the other three the *Balantidia* had multiplied much more rapidly than the *Troglodytella* and outnumbered them. The latter, however, were still active and both *Troglodytella* and *Balantidia* could be seen

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[1] From the department of protozoology, Johns Hopkins School of Hygiene and Public Health. The writer wishes to express his appreciation to Drs. Van Volkenburgh and Long and the Committee on Cold Research, from whose chimpanzee the material for this work was secured.

[2] E. Reichenow, ''Den Wiederkäuerinfusorien verwandte Formen aus Gorilla und Schimpanse,'' *Arch. f. Prot.*, 41: 1–33, 1920.

[3] J. Buisson, ''Les infusoires ciliés du tube digestif de l'homme et des mammifères,'' Trav. Lab. Parasit. Fac. Méd., Paris, 1923.

[4] M. Tanabe and E. Chiba, ''A New Culture Medium for *Endamoeba histolytica*,'' *Acta Med. in Keijo*, 11: 1–4, 1928.

boring into the slant. At about this time unfavorable conditions set in in the tubes and multiplication of both ciliates seemed to cease, and at the end of the seventh day, all of both types were dead.

Five tubes were inoculated for the first subculture. Only two of these were positive at the end of 48 hours. In these two the *Troglodytella* seemed to have multiplied considerably at the end of 48 hours and dividing individuals could be seen. The *Balantidia* multiplied much more rapidly, however, than the *Troglodytella* and at the end of 72 hours far outnumbered them. Both types remained active until the end of the sixth day when they all died. Second subcultures were made at the end of 48 hours. In these, twenty-four hours later, the *Balantidia* outnumbered the *Troglodytella,* and, although the latter were alive at the end of 96 hours when subcultures were again made, only the *Balantidia* survived this transfer.

This experiment was repeated several times with the same result and then several other media[5, 6, 7] were tried but without success. It is possible that the failure of continued cultivation of the ciliate may not have been due so much to any fault of the medium as to the fact that such frequently repeated transfers does not give time for sufficient multiplication as it does in the case of the *Balantidia,* a smaller ciliate. This problem is being worked on at the present time in this laboratory.

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THE EXPERIMENTAL TRANSMISSION OF ANAPLASMOSIS BY DERMACENTOR VARIABILIS

ABOUT a year ago the experimental transmission of bovine anaplasmosis by the brown dog tick, *Rhipicephalus sanguineus,* was reported by the writer[1] from this laboratory. This tick, although very widely distributed throughout all tropical countries of the world, is only known to occur in Texas, Louisiana, Mississippi, Florida, Kansas, Ohio, Pennsylvania and New York so far as this country is concerned, whereas anaplasmosis occurs in an area which, while not yet well mapped, certainly extends not only beyond the zones within which the related disease, piroplasmosis (cattle tick fever), is now confined, but also outside the original range of enzootic bovine piroplasmosis. It was pointed out, therefore, that if anaplasmosis is tick-borne throughout its entire range, it should have, judging from the distribution of ticks in the United States, at least two other species of ticks as its carriers. The experimental evidence presented in the present paper incriminates, as a carrier of anaplasmosis, another tick, *Dermacentor variabilis,* a species important because of its wide distribution and host range. This tick occurs on the Pacific coast and appears to be wide-spread east of a line extending south from the middle of the Canadian border of North Dakota to about Corpus Christi, Texas. It is not known to be present in the Rocky Mountain States. There is grave danger, therefore, that this tick may carry this destructive disease into many areas that hitherto have been considered outside the enzootic range of anaplasmosis.

EXPERIMENTAL CONDITIONS

Since not only the adults but also the larvae and the nymphs of three-host ticks drop to the ground after engorging, it is necessary in experimental work to devise means of retrieving the engorged ticks so that they will not be lost in the stable litter. When available, therefore, bulls have been used in preference to cows since the ticks could be held in a bag which was attached by means of adhesive tape to the bull's scrotum. For the experiments reported in the present paper, the bulls were purchased late in the fall in an area in Colorado where nothing resembling anaplasmosis is known to occur and were shipped immediately to Jeanerette, Louisiana, where they were confined in a screened barn. A description of this barn in which the bulls were kept out of contact with biting flies and other ectoparasites except the ticks used in the experiments has been published by the writer.[1] Bulls that have been held in this barn and not yet used for experiments were checks on the work; during the work herein reported five such checks were held and all of them remained uninfected. Furthermore, during the past three years, 68 head of cattle have been held in this barn, some of them as long as 18 months; except when experimentally transmitted, not a single case of anaplasmosis has been noted.

EXPERIMENTAL PROCEDURE

Many unengorged and partly engorged adults of *Dermacentor variabilis* were taken from cattle in Mississippi and Florida during April and May, 1931, by tick inspectors under the direction of Dr. Hartwell Robbins, of the U. S. Bureau of Animal Industry, and by Dr. T. W. Cole, of the U. S. Bureau of Animal Industry. These ticks were sent alive to the laboratory at Jeanerette, Louisiana, where they were used as follows: (1) Adults were allowed to engorge on a bull with clinical anaplasmosis, the females

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[5] E. Schumaker, "The Cultivation of *Balantidium coli,*" *The Amer. Jour. Hyg.*, 13: 1, 281–295, 1931.

[6] Sidney Margolin, "Methods for the Cultivation of Cattle Ciliates," *Biol. Bull.*, 59: 3, 1930.

[7] A. Schourenkova and V. Nossine, "Le culture du *Balantidium coli l'ovigen humaine,*" La presse medicale, 10: p. 1686, 1930.

[1] C. W. Rees, "The Experimental Transmission of Anaplasmosis by *Rhipicephalus sanguineus,*" *North American Veterinarian,* September, 1930.

oviposited in the laboratory, and the larvae engorged on two susceptible bulls; (2) the larvae engorged on a clinical case of anaplasmosis and the nymphs from these larvae engorged on two susceptible bulls; and (3) the nymphs engorged on a clinical case of anaplasmosis and the adults from these nymphs engorged on two susceptible bulls. In this way anaplasmosis was transmitted to the last four of the six susceptible bulls, transmission occurring in the moves from larvae to nymph and from nymph to adult. Since the first two bulls have not thus far reacted, the larvae did not "inherit" the infection from their mothers, *i.e.*, the etiological agent of anaplasmosis did not persist in the eggs of the ticks in the step from adult to larva, as is the case with the etiological agent of bovine piroplasmosis.

TEST OF HEREDITARY TRANSMISSION

On May 20, 1931, some unengorged adults of *Dermacentor variabilis* were permitted to engorge on bull No. 47, and on May 25–26 seven engorged females were removed. Bull No. 47, having been splenectomized on May 13, had clinical anaplasmosis during the time of this engorgement. The severity of this attack was demonstrated by the fact that on May 26, 375 erythrocytes per 1,000 were found to be infected with *Anaplasma*. The female ticks oviposited in the laboratory, and from June 30 to July 8 several thousand larvae engorged on a susceptible bull, No. 71. Several thousand other larvae from these females engorged from July 13 to July 20 on another susceptible bull, No. 68. As stated above neither of these bulls has reacted to anaplasmosis. Their susceptibility has not yet been proved by the injection of virulent blood. The blood of bull No. 47 has, however, been proved to be capable of transmitting anaplasmosis by injecting about 40 cc of it on May 25 into a susceptible bull No. 53. No. 53 reacted to anaplasmosis on June 9 and died on June 12.

LARVA TO NYMPH TRANSMISSION

Many of the partly engorged female ticks oviposited in the laboratory without further engorgement; other females were permitted to engorge on rabbits. From the eggs of both lots of these females many larvae were hatched, and on July 7 the larvae were placed in a bag which was attached to bull No. 65. Bull No. 65 had very severe clinical anaplasmosis at this time. He had been inoculated intravenously on June 16 with virulent blood from bull 46 and reacted to anaplasmosis on July 7. On July 13 a count showed that 376 erythrocytes per 1,000 were infected with *Anaplasma*. A blood count on July 17 showed only 1,140,000 erythrocytes per cubic millimeter and there were 19,600 white blood cells.

The larvae engorged until July 14 and molted in the laboratory to nymphs which were divided into two lots. On July 29 one lot was placed on a susceptible bull, No. 62. However, on August 5 no engorged nymphs could be found on this bull, though many remained unengorged in the bag. On this date other nymphs were added to those already in the bag and the latter was reattached to the scrotum. These latter nymphs were from another lot of larvae which had engorged from June 28 to July 5 on bull No. 46. Bull No. 46 failed to react to anaplasmosis after blood injection on April 13. He was, therefore, splenectomized on June 16 and a mild case of anaplasmosis was diagnosed on June 29. There was only a slight rise in temperature and the *Anaplasma* were never numerous but were present in the smears for about six weeks. The virulence of the blood of this bull No. 46 was proven because as stated above he was the "donor" of the blood used on June 16 to inject into bull No. 65.

Only 14 engorged nymphs were removed (August 10 to August 15) from bull No. 62, but many were found to have been crushed in the bag. Bull No. 62 reacted to anaplasmosis on September 2. The incubation period was, therefore, not longer than 35 days.

On August 4, the other lot of nymphs mentioned above as from the larvae that engorged on bull No. 65 were placed on bull No. 67. Thirty of them were removed, engorged, from August 9 to August 15. Bull No. 67 reacted to anaplasmosis on September 4. The incubation period, therefore, was not longer than 32 days. Both bulls No. 62 and No. 67 had irregular temperatures, fluctuating between 102° F. and 106° F., until about September 15. Anaplasma were numerous, as were also the characteristics of severe anemia. On September 12 the blood counts were as follows: Bull No. 62, erythrocytes 2,460,000, leucocytes 14,600 per cu mm; bull No. 67, erythrocytes 1,460,000, leucocytes 14,300 per cu mm. However, neither bull lost his appetite nor had other discernible symptoms of severe illness. The infectivity of the blood of these bulls has not yet been tested by injection into susceptible cattle.

NYMPH TO ADULT TRANSMISSION

Other nymphs of *Dermacentor variabilis* were secured by engorging the larvae on rabbits. On July 14 several hundred of these nymphs were placed on bull No. 65. Seventy-six of them engorged and were removed on July 20 to 22. Bull No. 65 was convalescing from anaplasmosis during this time, having reacted, as noted above, on July 7. He was still weak and very anemic and occasional *Anaplasma* could still be found in the smears. The engorged nymphs molted in the laboratory to adults and on August 10 about half of them were placed on bull No. 73, the other half on bull No. 74. Between August 17 and August 21, five engorged females were removed from No. 73 and 9 from No. 74. A number of males, not counted, were also removed from each bull. Bull No. 73 reacted to anaplasmosis on September 13, and bull No. 74 on September 14. The incubation periods were, therefore, not more than 34 and 35 days, respectively.

DISCUSSION

The data of the present paper appear to warrant the following general statements:

1. Larvae of *Dermacentor variabilis* may acquire anaplasmosis by engorging on a carrier, *i.e.*, a bovine in which the blood carries the etiological agent of this disease, and nymphs which develop from these larvae may transmit anaplasmosis to susceptible bovines.

2. Nymphs may become infected by engorging on a carrier, and adults which develop from these nymphs may transmit anaplasmosis to susceptible bovines.

In the present experiments the adult female ticks which engorged on carriers did not transmit anaplasmosis to the larvae of the next generation. More experimental work is needed, however, to determine whether or not hereditary transmission by this tick may occur. Had the experiment been tried, the nymphs or the adults of the second generation might have transmitted the infection, even though the larvae failed to do so. Furthermore, it may be possible for females to become infected either from larvae or nymphs rather than from engorging directly on a carrier and to transmit the disease to the larvae, nymphs or adults of the next generation.

It is possible, though not at all probable, that the nymphs and the adults which were used with success in the experiments of the present paper "inherited" their infections from the adults which were sent from Mississippi and from Florida. Be that as it may, the important feature of this work is that *Dermacentor variabilis*, which is one of the most widely distributed ticks in the United States, will serve in the transmission of anaplasmosis. This discovery warrants the serious attention of all those engaged in dairying or in the production of beef cattle because, as stated above, this destructive disease may be spreading at the present time into new areas.

It has been found that ticks of several genera can and do transmit anaplasmosis in various parts of the world, and with this evidence to the effect that the etiological agent of the disease has so little specificity in its requirements for an intermediate host one is safe in assuming that other ticks, not yet known to transmit anaplasmosis in the United States, actually do transmit it. Certain ones of these ticks, if incriminated, would suffice to make the known distribution of anaplasmosis coincide with the known distribution of carriers.

It is of interest to note that *D. variabilis*, convicted here of carrying anaplasmosis of cattle, has recently been incriminated as a carrier of a disease indistinguishable from Rocky Mountain spotted fever in man. These findings bring this tick to the front as a parasite of major importance.

SUMMARY

Under properly checked and controlled conditions, the writer has succeeded in transmitting anaplasmosis by means of *Dermacentor variabilis* as follows: (1) Ticks engorging as larvae on clinical cases of anaplasmosis transmitted the disease as nymphs to two susceptible bulls; (2) ticks engorging as nymphs on a convalescing case of anaplasmosis transmitted the infection to two susceptible bulls.

The test of "hereditary" transmission was negative when the ticks engorged as adults on a clinical case and the larvae of the next generation engorged on two susceptible bulls.

The wide-spread occurrence of *Dermacentor variabilis* in the United States indicates the danger that anaplasmosis may spread into new areas that have thus far been considered as outside the enzootic range of this disease.

The recent incrimination of *Dermacentor variabilis* in the transmission of what appears to be Rocky Mountain spotted fever has focused the attention of the medical profession and of public health officials on this tick, and this finding and the writer's finding indicate the need of further research on it as a tick of major importance in human and veterinary medicine.

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BOOKS RECEIVED

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SCIENCE

VOL. 75 FRIDAY, MARCH 25, 1932 No. 1943

The Rôle of Hypothesis in Economic Theory: PROFESSOR GRIFFITH C. EVANS 321

Criteria and Methods in the Investigation of Avian Coccidiosis: DR. ERNEST EDWARD TYZZER 324

Scientific Events:
Summer Meetings of the American Association for the Advancement of Science; The Astrophotographic Building of the Harvard Observatory; Tests to Determine the Nature and Source of the Cosmic Rays; Conferring of the Chancellor's Medal of the University of Buffalo on Dr. Frank A. Hartman 328

Scientific Notes and News 330

Discussion:
Natural Radiations from the Great Bear Lake Pitchblende Deposits and Gene Mutations: W. C. BROADFOOT. *Possibilities of Secondary Poisoning of Birds and Mammals:* F. E. GARLOUGH and JUSTUS C. WARD. *Spread of Broad Fish Tapeworm of Man:* DR. WM. P. N. CANAVAN. *Discovery of Conodonts in the Phosphoria Permian of Wyoming:* DR. C. C. BRANSON. *Academic Freedom in Italy:* PROFESSOR A. J. CARLSON 334

Scientific Books:
Planck's Universe of Modern Physics: HENRY MARGENAU 338

Scientific Apparatus and Laboratory Methods:
A Modification of the Osborne-Mendel Salt Mixture Containing only Inorganic Constituents: DR. LAURENCE G. WESSON. *A New Kahn Antigen Mixer:* DR. CHARLES GURCHOT. *A Simple Method for the Study of Living Fresh-water Sponges:* DR. JAMES T. PENNEY 339

Special Articles:
Insects as Vectors of Yellow Dwarf of Onions: C. J. DRAKE, H. M. HARRIS and H. D. TATE. *The Pre-Oligocene Stratigraphy of Porto Rico:* HOWARD A. MEYERHOFF. *The Dependence of Physics on the Mathematical Preparation:* A. A. BLESS 341

Science News 10

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THE RÔLE OF HYPOTHESIS IN ECONOMIC THEORY[1]

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THE distinction between a natural and a theoretical science lies essentially in the presence or absence of a free spirit of making hypotheses and definitions. In a natural science facts are recognized and systematized, with a purpose purely descriptive, but as the same field of knowledge is investigated in theoretical fashion, definitions become constructive rather than denotive, and hypotheses are introduced and tried out, in order to see what sort of results may be deduced from them. If the chains of deductive reasoning are complicated the science is driven to employ a characteristic method for their simplification. The mathematical method is at this point a requirement for progress.

Mathematics itself is not always completely theoretical. In geometry, we still reason from "general" geometric figures, much in the manner described by Kant, and are content with that kind of reasoning until we encounter contradictions which force us to make a further analysis. Even when we know that a complete analysis is possible, and the nature of the system completely definable by more or less logical postulates and definitions, we are sometimes inclined, as mathematicians, to turn that analysis over to the logicians, and forget it.

The question naturally arises as to the degree to which we may speak of a theoretical economics, and the extent to which we may call it mathematical.

In the first place, we notice constructive definitions. We do not usually give such a definition of a concept like capitalism, contenting ourselves with denoting the thing as it exists in certain systems, saying America and France are capitalist countries, but Russia is not. On the other hand, when we define rate of interest, rate of exchange, price, velocity of circulation, income tax, we have definitions given entirely in terms of previously acquired concepts. Terms which are in part given by means of earlier concepts and in part by referring to illustrations of them, so that their definitions are partly constructive and partly denotive, are those like monopoly and competition.

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[1] Delivered at a joint session of the Econometric Society and of Section K of the American Association for the Advancement of Science, January 1, 1932.

As far as a definition is constructive, relations may be deduced from it and other such definitions by a mathematical process. In this manner, from the definitions of price and velocity of circulation we deduce the "equation of exchange"; from the definitions of price and trade indices we express this same equation in another form. We can give the "dimensions" of all quantities fixed by constructive definitions. The mathematics of finance is obtained merely by using the definition of the rate of interest, and combining it with definitions of present value or value at an arbitrary time. Strange as it may seem to the novice, one or two such definitions may thus lead to an extensive body of real knowledge.

But we do not in this way exhaust the entire body of economic theory. In fact, we may say that the main object of economic theory is to make hypotheses, to see what relations and deductions follow from such hypotheses, and finally, by testing the consequences in comparison with the facts of existing economic systems, to describe them in terms of those hypotheses.

Demand is a concept which, according to Marshall, is destined to occupy continually increasing prominence in economics. What do we mean by demand? What hypotheses are connected with it? Perhaps we may say that the demand for a commodity is the amount of it which would be bought in unit time in a given "state" of the system. But then we must add some hypothesis or definition as to what constitutes the "state" on which the demand depends, for it is not practicable to have very many variables. We may, for instance, consider the following assumptions, which are not by any means a complete list of those which have practical meaning;

(1) $y = f(p)$, p the price of the commodity,
(2) $y = f(p, \frac{dp}{dt})$
(3) $y(t) = f(p(t-T))$, T a constant,
(4) $y(t) = f(p(\tau))$, τ all values between $t-T$ and t,
(5) $y = f(p_1, p_2, \ldots, p_k)$, the p's being prices of several commodities.

We might perhaps start with (1) and make a simple approximate study of equilibrium, for in that case several of the possible hypotheses become identical, the prices being assumed to be mere constants. But if we extend our investigations to moving prices our results do not have the same degree of generality, but depend on the particular one of the hypotheses which we assume, these hypotheses for variable prices being all different. We must then for the sake of theory separate carefully the various systems which depend on different hypotheses, and not regard as results, in one system, conclusions which follow only from the postulates of another.

A central concept in economics has been that of utility. This has sometimes been regarded as a psychic quantity, to be identified with satisfaction or pleasure. But underneath such a definition there must lie assumptions, tacit or explicit. Even though we are not willing to assume that this psychic quantity is directly measurable, if we are to use it in equations we have nevertheless to be able to add small increments of it, to compare its rates of change, etc. What, for instance, would a writer like Jevons need to assume about it?

Let S stand for this satisfaction-quantity, let χ stand for a quantity of a particular commodity, and $\dot{\chi}$ for its increase per unit time. Following Jevons[2] we write U as the intensity of sensation or degree of utility, due to increase of $\dot{\chi}$, and regard it as a new kind of psychic quantity. We are supposed to be able to compare these degrees of utility or sensations for various quantities, and we regard U therefore as having some kind of dimension of its own, not necessarily calculable in terms of the dimensions of physical quantities. Let [U] be the dimensions of U, [S] the dimensions of S. Then the pleasure V caused per unit time by a rate of consumption $\dot{\chi} = d\chi/dt$ is a quantity like $U\chi$ and has dimension

$$[V] = [U]\,[\dot{\chi}] = \frac{[U]\,[\chi]}{[t]}.$$

But the total pleasure is like $\int V\,dt$ and therefore has dimensions

$$[S] = [Vt] = [V]\,[t] = [U]\,[\chi].$$

In other words:

$$[\chi] = \frac{[S]}{[U]}.$$

Accordingly, no matter what the commodity χ, its dimensions are given by the above formula. All commodities are quantities of the same dimensions. This means that we can evaluate a unit of one commodity in terms of the unit of another, in the sense that if the unit of pork is changed to one twice as large, the unit of fountain-pens must also be changed to one twice as large, in order for the economic equations to have any meaning. How are appropriate units to be found, in the first place? To say the least, the situation is inconvenient.

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[2] Jevons, "Theory of Political Economy," Ch. III, IV, London, 1871.

Conceivably we object that the particular treatment given by Jevons is unnecessary, and that another based on similar ideas would not necessarily involve the same difficulties—the difficulties arising from the fact that the intensities U are regarded as a single kind of psychic quantity. We shall look at the situation therefore from a less restricted point of view, and consider a theory which does not require the explicit use of any "psychic" quantity.

We leave out of account the question as to whether or not utility is itself measurable, but suppose that there is a quantity associated with it which is measurable, and whose measure we may call an index of utility. If utility is measurable, the measure of utility itself may be taken as the index of utility. Otherwise, we are in the same situation as when we take temperature as an index function for warmth. For any state of the system, accordingly, we assume that there is a number, which, with reference to the individual, may be called the index of that state, and the individual's preference for one state or another is reflected in the magnitude of the corresponding index values. *If it is an index of utility each individual tries to make it a maximum.* We have thus arrived at a definite hypothesis, and many economists have tried to make it a basis for a general theory of economics.

We can make an estimate of the generality of such a system. In the first place, it is essentially competitive. If we add all the individual index numbers together to form a social utility function, we can not say, although many have said so, that society as a whole works to make this total function a maximum. For that is the same as saying that the maximum of a sum is necessarily the sum of the maxima of the parts—which is absurd. Hence a cooperative aspect of the system—which is so pronounced in modern society—must be introduced as an extra hypothesis. Will this make too many hypotheses for the number of independent variables?

Consider the process by means of which such an index number may be set up. Presumably two situations which are widely different can not be compared, as they are, directly, but only through a process, consisting of small steps, by means of which one step is transformed into the other. That is, we do not compare directly the situation (x_1, y_1, z_1) with the situation (x_2, y_2, z_2), but the state (x, y, z) with the neighboring state $(x+dx, y+dy, z+dz)$. That is, we write

$$dI = X\,dx + Y\,dy + Z\,dz \qquad (6)$$

X, Y, Z being quantities that depend on the state (x, y, z), *and then decide whether the change* (dx, dy, dz) makes dI positive or negative or zero.

But now we encounter another difficulty. If the state is given by two numbers (x, y) we know that there exists generally a function I such that dI is positive, negative or zero according as

$$X\,dx + Y\,dy > 0,\ < 0 \text{ or } = 0.$$

It is obtained by a proper choice of the integral of the differential equation

$$X\,dx + Y\,dy = 0$$

In other words, we can build up an index function by means of the curves of indifference. But if the state of the system is given by three or more numbers we also know that there does not exist in general such an index function. The expression of this fact in mathematical terms is the statement that an equation like

$$X\,dx + Y\,dy + Z\,dz = 0$$

is not "completely integrable." If we wish to have a utility function we must introduce some hypothesis on the coefficients X, Y, Z.

One simple case is that emphasized by Pareto in which X depends only on x, Y on y, Z on z; for in that case we may write I as some function of the quantity

$$\int X\,dx + Y\,dy + Z\,dz$$

The general condition for three variables, in order that I should exist is

$$X\left(\frac{\partial X}{\partial y} - \frac{\partial Y}{\partial z}\right) + Y\left(\frac{\partial X}{\partial z} - \frac{\partial Z}{\partial x}\right) + Z\left(\frac{\partial Y}{\partial x} - \frac{\partial X}{\partial y}\right) = 0,$$

which seems to have no particular economic significance.

If this condition is not satisfied, and the general integration can not be carried out, the summation of $X\,dx + Y\,dy + Z\,dz$ from one state (x, y, z) to another will depend on the order in which the various increments dx, dy, dz are taken during the process. *It will thus depend on the particular process by means of which we pass from the one state to the other,* but not merely on the two states themselves. It has sometimes been stated that this summation nevertheless affords a satisfactory determination of I, on the ground that the process is regulated by the customs of industry and markets. But this again is the same as saying that certain relations already hold between the variables x, y, z, . . . ; and they are no longer independent. Moreover, if, in spite of these relations, there remain three or more independent variables, the difficulty still persists.[3] Hence we must assume that all our situations relative to a utility function must not contain more than two independent variables, or else we must introduce directly a postulate of integrability. It seems an arbitrary limitation.

Having obtained or assumed such a function, let us suppose that we make it a maximum. We are inclined to set dI equal to zero, and without further consideration to regard the problem as solved. But if the maximum occurs on the boundary of the region of variation of the variables, as is likely, for instance, in the case of an individual who is trying to corner the market, there is no need for dI to be zero. Usually, also, there are various subsidiary conditions —restraints, "obstacles," necessary relations between the variables, which have to be satisfied at the same time. And altogether, these equations and the equations given by $dI = 0$ furnish as many equations as there are unknowns. But this is purely an automatic process. If we overlook a restraint, $dI = 0$ merely furnishes us one more equation than it did previously. It is absolutely no check on the correctness of statement of the problem that the number of equations is the required number.[4]

Finally, if we are to study group phenomena and distinguish between cooperative and competitive elements in the system, we must, as we have already remarked, introduce also group utility indices or group "ophelimities," and these have no transparent relation to the individual ones. The individual can not make his individual utility a maximum at the same time that society makes the sum of all the utilities a maximum, for the maximum of a sum is not in general the sum of the maxima of the separate terms. The group utility function can not, therefore, with this interpretation of the problem, be the sum of the utility functions of its members. And from this point of view the doctrine of "laissez faire" lacks mathematical foundation.

It is apparent, from what we have said, that the use of a utility function reduces us to the study of a very special case. The special case may, of course, be worth while. But in the terms heretofore used this study is entirely abstract; moreover, if it is to be made sound, it is dependent on the introduction of a number of special conditions which are not statable by means of economic concepts. The result is merely a collection of equations which have no relation to economics, except in the names that are used. Would it not be better than to abandon the use of the utility function, and investigate situations more directly in terms of concrete concepts, like profit and money value of production, in order to take advantage of the fact that money is fundamental in most modern economics and to use the numbers which it assigns to objects?

Concrete concepts suggest concrete hypotheses.

CRITERIA AND METHODS IN THE INVESTIGATION OF AVIAN COCCIDIOSIS

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WHILE the economic importance of coccidial infection in domestic fowls is quite generally recognized, much of the investigation in this field has yielded only conflicting results and all too little in the way of actual accomplishment. The chief difficulties appear to have been due to the failure to recognize that a number of distinct species of *Eimeria* occur in poultry, even in a single host species, and also to the failure to employ adequate controls. Thus the coccidial infections encountered in various domesticated birds have been commonly attributed to a single poorly defined species, usually alluded to as "*Eimeria avium*." While the usual text-book description of the coccidium life cycle appears to have been understood and widely utilized, certain well-established principles have been frequently ignored.

It is the purpose of this communication to review some of the methods employed by the author in previous work in this field and also to discuss certain criteria which have been found to have application in a more recent investigation carried on in collaboration with H. Theiler and E. E. Jones.[1] The recognition of the fact that a single avian host may harbor more than one species of *Eimeria* appears essential to a proper approach to this field of work. In order to learn the reaction of the host to each species of parasite, or indeed to determine to which ones the more serious disease conditions are attributable, it has been found advantageous to work with infections produced experimentally with single species. Since coccidia do not lend themselves to artificial propagation outside the bodies of their respective hosts, the determination of their specific characters makes it necessary to substitute for the test-tube of the bacteriologist a suitable experimental animal. Hence the isolation of a given species is accomplished by the selection of proper material, while its propagation is carried on by experimental infection.

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[3] This apparently is not a unanimous opinion among economists; *Cf.* the review of the author's "Mathematical Introduction to Economics" by Professor Henry Schultz (*Journal* of the American Association, December, 1931). It is assumed that a decision is possible as to which of two situations is preferable, or better, or more satisfying, even though each depends on several variables and without regard to processes of transformation; but we notice that this is itself merely the assumption of integrability. It is warrantable only for a limited class of problems. How many individuals, for instance, can decide, without reference to process, which of the two situations he desires—peace, or justice, in China?

[4] That we have the same number of equations as unknowns is a more or less adequate check on the correctness of statement of a problem when each relation comes directly from the problem or its intuitive analysis. At best the method is not satisfying, even when restricted to geometric or algebraic relations. But economists have been tempted to carry the idea over into these problems of maxima and minima, where, for the reasons given above, it is absolutely worthless.

Isolation may be accomplished in various ways. On occasion, infections with a single species of *Eimeria* present themselves, thus doing away with the necessity of artificial isolation. In such cases, sufficient acquaintance with the organism and a series of observations carried out on carefully conducted experimental infections are necessary in order to be sure that one is not dealing with mixed infections.

In some instances the selection of material from a given region of the intestine is all that is necessary to isolate a species. For example, in a mixed infection with *E. acervulina* and *E. tenella,* the fact that the development of the latter is commonly confined to the caeca makes possible the isolation of the former by collecting oocysts from the first portion of the intestinal tract. On the other hand, *E. tenella* may be isolated from such a mixture by taking the caecal mucosa for the source of oocysts after prolonged and thorough washing in running water to remove the *E. acervulina* oocysts that pass into the caeca from the small intestine. By this method we have been successful also in separating *E. necatrix* Johnson from associated *E. acervulina* infection.

By collecting the earliest oocysts to appear in an experimental mixed infection, it is possible to separate out the species having the shortest period of development. Likewise selection may be based on differences in the time required by the oocysts of various species to undergo sporulation.

In certain combinations of species, the most feasible method for the isolation of a species may be to obtain single oocysts. One way of accomplishing this is by the dilution method as employed by Miss Jones.[2] This is done by transferring material containing the mixture of oocysts into a succession of drops of fluid on a thin strip of moistened gelatin, which for convenience is placed on a sterile microscopic slide. When a drop is obtained containing a single oocyst of the type desired, the portion of the gelatin strip including the oocyst in question is then cut out and immediately fed to an uninfected bird. It will be readily understood, however, that it may be a time-consuming task to obtain by the dilution method an oocyst of a species which is poorly represented in a given mixture. Another method was employed when *E. maxima* was first encountered in a mixture with *E. acervulina,* in which its oocysts formed only a very small percentage of the total number present. Since the large size of the *E. maxima* oocysts rendered them readily distinguishable, single oocysts were isolated by the Barber micropipette, transferred to a small disc of moistened gelatin which was then lifted by sterile tweezers and placed far back in the pharynx of an uninfected chicken to make sure of its being swallowed.

Should a mixture of two organisms be encountered such as *E. tenella* and *E. necatrix,* which produce oocysts that are not readily distinguished one from another and that develop in the same portion of the intestinal tract, the most feasible procedure would appear to be to immunize birds against either one of the organisms which may be available in pure culture. Then on feeding the mixture of oocysts to the immunized birds, a pure strain of the other species may be obtained.

In reviewing the criteria that we have considered in recognizing species, attention should be called to the common fallacy of differentiating species on the measurements of oocysts. First of all, the measurement of oocysts furnishes no certain index as to the purity of the material. Slight representation of additional species may have no appreciable effect on the curve plotted and, unless other characters are taken into account, there is no means of knowing whether a curve obtained is typical of any species. There is also considerable evidence indicating the occurrence of size strains within a given species. It has been shown by Miss Jones[3] that an infection derived from a single oocyst furnishes oocysts that give a distinctly bimodal curve when the measurements are plotted and that this character is maintained throughout successive transfers. She has also shown that the oocysts may be larger in light infections than in heavy ones.

In view of such variation within a species, the consideration of other features in addition to the dimensions of the oocyst appears to be essential for the differentiation of species. For this purpose we have found the following characters useful: the period required for development, *i. e.*, the time from the feeding of oocysts to the discharge of oocysts; the sporulation time; the gross topography of the infection; the distribution of organisms in the epithelium, *i. e.*, whether scattered or in colonies, superficial or deep, in free surfaces or in glands, *et cetera;* the gross and microscopic pathology of the infection; the morphology of the developmental forms of the organisms; and finally the absence of cross immunity. Notwithstanding this rather formidable array of characters, differentiation of the individual species is not difficult once they have been recognized, since certain combinations of characters are practically specific. Thus the occurrence of superficial, whitish, transversely extending, elongate spots composed of oocysts in the mucosa of the upper portion of the intestine furnishes a reliable indication of *E. acervulina*, while the ocurrence, in association with hemorrhage, of rounded whitish spots, occurring in greatest number in the middle portion of the intestine, seen best from the serous surface and composed of numbers of cells containing large schizonts furnishes a diagnosis of *E. necatrix*.

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[1] A full account of this work is in the hands of the publishers and will appear in the *American Journal of Hygiene.*

[2] E. E. Jones, "Size as a Species Characteristic in Coccidia: Variation under Diverse Conditions of Infection." To appear in *Archiv für Protistenkunde.*

[3] E. E. Jones, *loc. cit.*

In addition to the difficulties arising from the confusion of species, the failure to recognize certain fundamental principles in many instances vitiates the results of investigation. In contrast to the experimental bacteriological infections in which no elaborate precautions for the isolation of stock animals are necessary, in experimental studies of coccidial infection, the possible occurrence of adventitious infection must always be taken into account. The ubiquity of coccidial infections, their possible introduction by the attendant, or in food material, or by insects, rats and mice, is apparently often disregarded. The demonstration that the ingestion of a single sporulated oocyst may result in infection serves to indicate the necessity of carefully planned controls for all crucial experiments in this field. While it seems to have been recognized that coccidial infection tends to be self-limited, the duration of single infections in the absence of any opportunity for reinfection appears not to have been determined heretofore. We have found that various Eimerian infections, even in the absence of any appreciable protective reaction on the part of the host, disappear spontaneously, following the completion of the developmental cycle. This type of infection, in contrast to bacterial infections, is thus dependent for its continuance on reinfection through the ingestion of oocysts. That a certain proportion of sporulated oocysts may pass through the intestine unhatched is often disregarded, although this fact may be readily demonstrated either by direct examination of fecal discharges or by placing control birds in the same cage with those fed oocysts.

That the severity of infection is primarily dependent upon dosage is also readily demonstrable; light infections with even the most pathogenic species furnish no symptoms and no more than microscopic lesions. The term "dosage," however, should apply to the number of infective forms which invade the tissues rather than to the number swallowed. Thus it has been found that approximately the same number of organisms fed to birds of one age will furnish a much heavier infection than when fed to birds of another age. It has been found also that greater protection is afforded the host by a heavy infection than by a light one. Among other things to be considered with reference to dosage is the movement of material through the alimentary tract of the bird. Material fed to the chicken commonly makes its appearance in the feces in slightly more than an hour's time. Since no very coarse material is ever found in the caeca, it is apparent that not all material passing through the small intestine enters these tubes, but there is a sampling of the more finely comminuted material. Thus many of the sporozoites of *E. tenella* hatching in the small intestine fail to enter the caeca, and are lost in the fecal discharges, as may be demonstrated by microscopic examination. Likewise, by far the greater proportion of the merozoites produced in the small intestine by *E. necatrix* pass out in the feces. In fact, merozoites are regularly demonstrable in the discharges, even in light infections of this species.

There are certain precautions that should be taken as a matter of routine in experimental coccidial infection, and others that may be taken with special objectives in view. It is a fortunate circumstance that the day-old chicks which may now be purchased at all seasons of the year are usually free from coccidial infection. On arrival, they should be furnished a sterilized equipment, consisting of cage, heat unit, feed and water dishes, and thenceforth kept in a room apart from infected chickens. All mash, grit and litter which they receive thereafter should be made into packages of appropriate size and sterilized in the autoclave as a matter of routine. Water may be taken from the hot water tap. The attendant should have nothing to do with infected birds, which preferably should be personally cared for by the investigator. The rooms in which either stock or experimental birds are kept should be well screened and free from cockroaches, flies and other insects. Access of mice to cages and food material should be carefully prevented. Propinquity is another important feature to take into consideration; the activity of chickens in scattering material about makes accidental infection a matter of frequent occurrence, especially when lots of birds are kept in the same room with other lots that are discharging oocysts. The proof of the success of measures to protect experimental birds from accidental infection rests on the freedom of stock from infection as determined by periodic examination of discharges. Accidental infection does not, however, necessarily vitiate one's results, especially if it is immediately recognized. The time of its occurrence may indicate an accidental infection, and its morphological characters may make possible its differentiation from the experimental infection.

The assumption that chicks kept on false cage-bottoms of wire mesh will not become reinfected is unwarranted. While this measure may lessen the opportunity for reinfection, nevertheless fecal material adheres to the wire so that it is likely to become mixed with scattered food and later ingested or it may contaminate the feet and be picked off subsequently by the bird. Fecal material is commonly found in food dishes, thus furnishing ample opportunity for reinfection. Practically the only way to prevent reinfection is to change to successive sterile environments at periods less than the sporulation time of the oocysts, *i. e.*, within each twenty-four hours. The continued absence of infection in normal control birds after their introduction into the cage with the infected ones furnishes evidence as to the efficacy of the above measures.

In the course of our investigations on immunity, the question arose as to whether the birds that were resistant to reinfection were also no longer discharging organisms. While it would appear that no test thus far tried out for the presence of organisms in the fecal discharges is wholly infallible, yet certain procedures carried out at frequent intervals probably furnish a reliable indication. Infection may be disclosed by the direct method of microscopic examination, by which may be discovered not only oocysts, but also merozoites, and it not infrequently happens, at least with some species, that the merozoites may be present when no oocysts are demonstrable. The flotation method of concentration, using strong salt solution, works well for determining the presence of oocysts, but after such treatment the oocysts are often unsuitable for subsequent transmission experiments. By keeping fecal discharges for two or three days in 2.5 per cent. potassium dichromate solution and then feeding the material to normal birds, it is frequently possible to demonstrate the presence of oocysts in material in which they could not be found microscopically. Since by this method the samples fed represent only a fraction of the discharges of the bird tested, it is quite possible that the existence of light infections may not always be discovered. Even on combining both the microscopic and feeding tests for the presence of infection, it can not definitely be demonstrated that a bird on a given occasion harbors no infection, for the discharge of organisms is subject to considerable fluctuation. However, in groups of birds such tests made repeatedly furnish an indication of the trends of infections, *i. e.*, whether increasing in intensity or dying out.

Failure to employ adequate precautions to prevent accidental coccidial infections or to recognize them when they occur doubtless accounts for many of the fallacies and ill-founded conclusions that appear from time to time. For example, reports on the transmission of coccidial infection to quite unrelated host species are not uncommon in the literature. A scrutiny of such reports yields no evidence of proper isolation of the test bird or sterilization of its food, while the possibility of the intestinal contents of the donor containing oocysts from other sources than itself appears not to have been considered. Concerning the latter possibility, Krijgsman's[4] success in infecting rabbits with *Eimeria stiedae* from the feces of rats that had been fed this organism is noteworthy. Another source of error is the failure to identify accurately the infection that may appear in the recipient in the course of cross-infection experiments. The mere occurrence of coccidial infection is hardly acceptable without definitely identifying it by further morphological and pathological studies. The time of occurrence of infection is of considerable significance, and in order to determine this, daily examinations for organisms in the discharges are necessary. Gross pathological features associated with coccidial infection should not be relied on without supporting evidence. For example, extensive fatal hemorrhage into the caeca and small intestine has been noted in turkeys, but we are not justified in regarding this as *E. tenella* infection without demonstrating organisms with the morphological and biological features of this species.

Unwarranted assumptions are frequently encountered in measures proposed for coccidiosis control. Thus the dipping of eggs for incubation purposes in antiseptics is advocated without determining whether it is possible for the oocysts to survive on the shell of the egg throughout the period of incubation. The absence of coccidia in most of the day-old stock on the market appears not to have been recognized. Furthermore, it is commonly assumed that coccidial infection, since it is of such serious consequence in poultry, should be wholly eliminated from the flock. The conclusion has been reached, however, in our recent investigations that the exposure of birds to light infection early in life protects them against serious injury from infection later on.

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[4] B. J. Krijgsman, "Overbrenging en prophylaxis der coccidiose." *Tijdschr. Diergeneesk.*, 56e (19): 1032–43. 1929. (Author's summary, *Biol. Abst.*, 5, No. 4, April, 1931.)

Once the multiplicity of the species of *Eimeria* infecting poultry is realized and the basic principles of such infections are understood, there is probably no other group of hosts in which coccidiosis may be studied so advantageously. While it is a rather difficult matter to maintain stocks of young mammals free from all such infections, "day-old" chicks are now available in reasonably large numbers throughout the year, and young turkeys, pheasants, *et cetera*, may be obtained at certain seasons. The uniform susceptibility of such hosts, the ease with which infection is produced and the regularity of results under laboratory conditions, all lend themselves to accuracy in this field of work. It is reasonable to expect that much may be learned also by the application of exact methods of observation and experiment to the practical problems in coccidiosis.

SCIENTIFIC EVENTS

SUMMER MEETINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SEVERAL years ago the council of the American Association for the Advancement of Science voted to hold summer meetings. The first of these meetings, held at Pasadena, California, last summer, will be remembered for its wealth of important scientific symposia and numerous excursions. Physicists, chemists and other scientists came from all parts of America to attend the scientific sessions held at that time.

The second meeting of this series of summer meetings will be held at Syracuse, New York, on June 20 to 25. For a meeting of national scope such as that of the association, Syracuse's geographical position is ideal. It is overnight from Eastern Canadian points, New England, New York, Washington, Baltimore, Philadelphia, Pittsburgh, Detroit, Cincinnati, and but slightly further from the South and Middle West. It is within 300 miles of one third of the population of the United States, and a ride of not more than eighteen hours will bring three quarters of the population of the United States to Syracuse. Such institutions as Syracuse University, Cornell University, the University of Rochester, Colgate University, Hobart, Wells and Union Colleges are within three-hour rides of Syracuse.

Preliminary indications are that the number of symposia at Syracuse will be much larger than the number at Pasadena. Extensive program plans are being made by a number of sections. Each of the fifteen sections of the association will plan to hold two or more sessions devoted to studies of special subjects. Already the programs of Section C (Chemistry) and Section N (Medical Sciences) are taking definite shape in this direction. Each local representative is working diligently with the secretary of the section which he represents. Indeed, the chairman of the local committee, Dean Hugh P. Baker, promises to replace any one who does not take an active part in the program planning. Only a few of the affiliated societies will meet with the Association at Syracuse, so that the section secretaries and the local representatives will be given the privilege of organizing the programs as they think best. Since the by-laws of the association forbid sections to hold programs competing with the programs of affiliated societies meeting with the association, this will offer to some of the section secretaries an opportunity which has never before presented itself.

The next summer meeting after that at Syracuse will be held in connection with the Century of Progress World's Fair at Chicago from June 19 to 30, 1933. The fair will make available a large sum of money which will enable the association to invite seventy-five distinguished foreign scientists whose expenses will be paid. From two to nine such guests will be invited for each section. It is planned to organize one symposium in the field of each of these distinguished guests and thus make it possible for American and European scientists to exchange views on subjects uppermost in their minds to-day. In addition to these sectional symposia, it is expected that the various affiliated societies meeting with the association at that time will hold sessions for the reading of papers.

Preparations for the World's Fair are rapidly nearing completion. The Hall of Science, covering five acres of land, will be the center of this mammoth undertaking. Indeed, here and throughout the fair the dependence of industry and civilization itself on science will be pictured. Nearly ten acres of floor space will be devoted to science exhibits.

CHARLES F. ROOS,
Permanent Secretary

THE ASTROPHOTOGRAPHIC BUILDING OF THE HARVARD OBSERVATORY

THE astrophotographic building of the Harvard Observatory was dedicated on Wednesday, March 23, and on that day there were scientific conferences and meetings in accordance with the following program:

I. MORNING SESSION. The Observatory Library at 10

o'clock. Conference on Astrophotographic Problems: Professor Harry H. Plaskett presiding.
- The Harvard Collection: Dr. Annie J. Cannon, curator of astronomical photographs.
- The Physics of the Photographic Process: Professor G. B. Kistiakowsky, department of chemistry, Harvard University.
- A Survey of Photographic Astrometry: Professor Frank Schlesinger, director, Yale Observatory.
- The Current Photographic Programs of the Harvard Observatory: Dr. Harlow Shapley, director, Harvard Observatory.

II. AFTERNOON SESSION. The Observatory Library at 2 o'clock.
- A. Acceptance by President Lowell of the Keys to the new Astrophotographic Building from Mr. Charles A. Coolidge, president of the Harvard Alumni Association, representing the architects.
- B. Conference on *The Time Scale*, under the auspices of the Harvard Chapter of Sigma Xi: Dr. Harlow Shapley presiding.
  - On the Concept of Time: Professor Percy W. Bridgman, department of physics, Harvard University.
  - The Astronomical Measurements of Intervals of Time: Professor Robert H. Baker, director of the observatory, University of Illinois.
  - The Age of Mankind: Professor Ernest A. Hooton, department of anthropology, Harvard University.
  - The Radioactive Base Line of Time Estimates: Professor Alfred C. Lane, department of geology, Tufts College.
  - The Geological Time Scale and its Applications: Professor Arthur Holmes, Durham University, England.
  - The Stability of the Solar System: Professor E. W. Brown, department of mathematics, Yale University.
  - Meteors and the Age of the Universe: Professor Ernst J. Öpik, Tartu University Observatory, Esthonia, lecturer in astrophysics, Harvard University.
- C. Reception to members of Sigma Xi and invited guests in the director's residence.

III. EVENING SESSION. The Observatory Library at 8 o'clock. Joint Meeting of the Bond Astronomical Club and the Staff of the Harvard Observatory.
- The Zodiacal and Planetary Symbols: Dr. Cecelia H. Payne, Harvard Observatory.
- Astronomical Sketches: Members of the Bond Club and the Observatory Staff.

TESTS TO DETERMINE THE NATURE AND SOURCE OF THE COSMIC RAYS

DR. ARTHUR H. COMPTON, professor of physics at the University of Chicago, has left for Panama, where he will make the first of a series of tests in various parts of the world to determine the nature and source of cosmic rays. Dr. Compton's work will be part of a cooperative study, involving a dozen physicists working in several parties under his direction, to measure the intensity of the rays which apparently come from interstellar space.

The cosmic ray meter consists of a steel "ionization chamber," containing argon at 30 atmospheres pressure. The cosmic rays penetrating the chamber set up an electrical current in the gas (argon) which is measured with an electrometer. A series of lead and copper spheres, weighing in all 200 pounds, shield the ionization chamber from local rays, permitting only the cosmic rays to enter. The Carnegie Foundation and the University of Chicago will share the expense of the projected study.

The objective of the expedition, according to Dr. Compton, is "more complete knowledge of the nature and place of origin of cosmic rays. A survey such as this should give the most adequate test that has yet been devised to distinguish whether the cosmic rays are photons, such as light and x-rays, or electrons, such as give rays to the earth's aurora. Because of the effect of the earth's magnetic field, electrons would give less intense rays near the equator than near the poles, and presumably there should be other variations with the geographical location."

The present project continues work which Professor Compton did last October on Mount Evans, Colorado, and in the Swiss Alps. The new measurements will be made at altitudes ranging from 7,000 feet to 26,000 feet. The tests on Mt. Chico in Panama will be followed by studies at Huancayo, Peru. Mt. Cook in New Zealand, Mt. Kosciusko in Australia, Mauna Kea in Hawaii and Mt. McKinley in Alaska are the next objectives. At the end of the summer Dr. Compton will return by way of Colorado, where further studies will have been made.

Three other cooperating parties will report at the end of the summer. One will take measurements on the Volcano Lanin in Patagonia and at Punta Arenas in Chile. A second, in charge of Professor S. N. Naude, of the University of Cape Town, will climb Mt. Winterhoek in South Africa, and possibly Mt. Brukkaros. In India, Professor J. N. Benade, of Punjab University, Lahore, will go to Mt. Nunga Purbat in Kashmir, third highest peak in the world, and will, if possible, make tests at several altitudes ranging as high as 20,000 feet or more. Professor Benade will then proceed to Kandy, Ceylon; Singapore, Straights Settlement, and Mt. Tjerimai, Java, for further measurements.

Negotiations are also being made with several independent groups, which are planning expeditions to the

North and South Polar regions within the next two years for the inclusion of physicists in the parties to make further cosmic ray measurements.

CONFERRING OF THE CHANCELLOR'S MEDAL OF THE UNIVERSITY OF BUFFALO ON DR. FRANK A. HARTMAN

AT commencement exercises on February 22, the University of Buffalo awarded the chancellor's medal, its highest honorary badge, to Dr. Frank A. Hartman, professor of physiology in the School of Medicine, for his work in extracting the vital hormone of the adrenal cortex. Dr. Hartman is the first member of the faculty to receive the medal, since it is reserved for the few who by some outstanding act or achievement bring greater dignity and honor to Buffalo in the eyes of the outside world. An excerpt from Chancellor Capen's remarks in making the award follows:

> The dominant function of the university is now no longer the preservation of the past; it is the creation of the future. How does the university create the future? By research, by experiment, by reducing the area of the unknown, by making new knowledge and reinterpreting old knowledge in the light of the new, and so furnishing society with new instruments to make life safer, more generous and more lovely. The terms "university" and "research" have come to be indissolubly associated.
>
> But the situation contains a paradox. The university, especially in America, now has many obligations. Its historic obligation to transmit the past bulks large and is very costly. It has acquired still other obligations that are contemporary with the moment, that consume much energy and attract perhaps undue attention. In consequence, research, which experience has shown to be the university's most important activity, shares always disadvantageously in the apportionment of funds and facilities. Research is still far too often in the American university a work of supererogation. It is a surplus good work performed at the sacrifice of ease and profit, out of devotion to a wholly idealistic cause. It is performed by a minority of the members of the university. But from these works of supererogation, from this treasury of grace, if one may continue the theological figure, have come not all, to be sure, but a large proportion of those facts and points of view which within the last two generations have ameliorated and enlarged social living.
>
> In the field of medical investigation the university has long had a practical monopoly. To university research in Europe and America the world owes most of the great discoveries that have controlled or vanquished one after another of the seemingly hopeless maladies to which humanity is subject.
>
> Those who see only the occasionally spectacular results of research in the medical sciences have little idea of what lies behind them. In hundreds of laboratories all over the world the process is going forward, quietly, without public notice, almost as a matter of daily routine. It is not attended by sudden revelations. The advance toward the goal which the investigator seeks is inch by inch. Unexpected blockades and dashed hopes are frequent, and retreats to a point whence a fresh start can be made. There enter into the process imagination, bold and hazardous conjecture, the patient distrustful following of leads, the endless repetition of checks and tests to make sure that nothing has been overlooked and that the same procedures will bring every time the same results. For most workers this is all, this and the recognition by fellow workers of foundations solidly laid for the future advance of science.
>
> Once in a while there comes to the rarely resourceful investigator brilliant success, then the applause of his professional associates, perhaps fame. Surely the man whose imagination and learning and technical skill have brought him to an important scientific discovery needs and wants no other reward. His cup is full.
>
> But whether he wants it or not is beside the point. These institutions that are dedicated to research may properly seize the occasion to say: "This is what we mean. This is the business to which we are committed. This servant of the common good is our man, an exemplar of our craft."
>
> For some months the University of Buffalo has been in a position to speak thus of one of its members. The discovery and preparation of cortin were in the best tradition of medical research. Years of baffling and painstaking experiment preceded the modest announcement of our colleague's success. Then, quite unheralded, followed the multiplying demonstrations of the effectiveness of the discovery; then renewed study and experiment, and at length national recognition modestly, almost reluctantly, accepted.
>
> The university to which he has brought honor now delights to honor him. Fortunately it is able to present him with a tangible token of its approval. The medal established by former Chancellor Charles P. Norton was intended to signalize publicly just such distinguished achievement.
>
> Frank Alexander Hartman, teacher, scholar, persevering and dauntless experimenter, discoverer of cortin, the council of the University of Buffalo awards the Chancellor's Medal to you, because through your investigations you have won rank among the leaders in the science of endocrinology and in so doing have "dignified Buffalo in the eyes of the world."

SCIENTIFIC NOTES AND NEWS

AT a recent meeting of the senate of the University of Dublin it was decided to confer the degree of Sc.D. on Dr. Ross G. Harrison, professor of comparative anatomy at Yale University.

ON the occasion of the dedication of the Graduate Education Building of the University of Chicago, the honorary degree of doctor of science was conferred on Dr. Edward Lee Thorndike, professor of education and director of the division of psychology of the Institute of Educational Research of Teachers College, Columbia University.

THE honorary doctorate of the mathematical faculty of the University of Göttingen has been conferred on Lord Rutherford, director of the Cavendish Laboratory and professor of experimental physics at the University of Cambridge.

THE colloid division of the Brunswick Chemical Society has awarded to Miss Pockels the Leonard Prize for 1931, and the Brunswick Technical High School has conferred on her the degree of doctor of engineering, *honoris causa.* Professor Wilhelm Ostwald, of Leipzig, presented the medal and the rector of the Technical High School delivered the doctor's diploma.

AT the meeting of the Washington Chemical Society, held on February 11, the Hillebrand award was presented to Dr. G. E. F. Lundell, of the Bureau of Standards, for work in connection with his book on "Applied Inorganic Analysis." This award is given annually for the greatest contribution made by a Washington chemist during the year. The speaker of the evening was Mr. Arnold K. Balls, of the U. S. Department of Agriculture, who discussed the chemistry of enzymes.

DIPLOMAS of honorary membership were conferred upon Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and on Mr. Charles T. Main, consulting engineer, by the Boston Society of Civil Engineers at its eighty-fourth annual meeting on March 16.

DR. JULES SCHOKALSKY, of Leningrad, U.S.S.R., president of the Russian Geographic Society, was recently elected correspondent of the French Academy of Sciences, for the Section of Geography and Navigation. He is known for his oceanographic work, especially in the Black Sea.

AMONG members elected in the division of science of the Bavarian Maximilian order for science and art are Dr. Walther von Dyck, professor of mathematics, and Dr. Arnold Sommerfeld, professor of theoretical physics, both of the University of Munich.

THE Council of the Royal Society has agreed to recommend for election into the society the following seventeen candidates: Professor Frederick Charles Bartlett, Professor Davidson Black, Dr. Frederick William Carter, Professor William George Fearnsides, Professor Felix Eugen Fritsch, Professor Joseph Alexander Gray, Professor John Burdon Sanderson Haldane, Professor Douglas Rayner Hartree, Dr. Karl Jordan, Professor Frederick Robert Miller, Sir Basil Mott, Bt., Dr. John Boyd Orr, Professor John Lionel Simonsen, Mr. Thomas Smith, Professor Hugh Stott Taylor, Professor Herbert Westren Turnbull, and Professor Warrington Yorke.

THE annual faculty research lecture for 1932 at the University of California was given on March 22, Charter Day, in Wheeler Auditorium, by Dr. William Hammond Wright, astronomer of Lick Observatory. The title of the lecture was "Viewing the Heavenly Bodies through Colored Glasses."

DR. ARTHUR O. LOVEJOY, professor of philosophy at the Johns Hopkins University, has been appointed the second incumbent of the William James lectureship at Harvard University for the first half of next year. Dr. John Dewey, professor of philosophy emeritus at Columbia University, was last year the first William James lecturer under the foundation for psychology provided with nearly $800,000 by the will of Edgar Pierce, formerly instructor in psychology at Harvard.

PROFESSOR JOHN A. JAMES, who for the past thirteen years has been assistant dean of the College of Agriculture of the University of Wisconsin, has been appointed dean and director of the department of agricultural education. The position of assistant dean will be filled by Dr. Ira L. Baldwin, of the department of agricultural bacteriology.

DR. H. ROSSBACHER, formerly superintendent of manufacturing development at the Kearny plant of the Western Electric Company, has been transferred to the Bell Telephone Laboratories as manager of vacuum tube manufacture.

LEAVE of absence from Harvard University has been granted to Professor Hubert L. Clark, for the second half of 1931–32, in order that he may take charge of the expedition of the Museum of Comparative Zoology in Australia.

THE Hepsa Ely Silliman Memorial Lectures will be delivered at the Sterling Chemistry Laboratory, Yale University, by Professor Owen Willans Richardson, of King's College, London, on April 18, 19, 21, 22, 25 and 26, at 4:15 P. M. The subject of these lectures will be "Molecular Hydrogen and its Spectrum."

DR. ANTON J. CARLSON, professor of physiology in the University of Chicago, conducted the tenth annual graduate course, sponsored by the Toledo Academy of Medicine, from March 21 to 25, on recent advances in physiology. Dr. Carlson gave two lectures each day covering, among other subjects, the anemias, control of the heart, control of blood pressure, oxygen therapy, the digestive secretions, motor mechanisms of the alimentary tract, dietary deficiencies, the endocrine glands and renal function.

THE *Journal* of the American Medical Association reports that Dr. Alphonse R. Dochez, professor of medicine, Columbia University College of Physicians and Surgeons, New York, gave the fifth course of lectures under the William Sydney Thayer and Susan Read Thayer Lectureship in Clinical Medicine at the Johns Hopkins Hospital, on March 22 and 23. Dr. Dochez spoke on "A Limited Consideration of Certain Aspects of Acute Infection of the Respiratory Tract."

DR. WALDEMAR T. SCHALLER, of the U. S. Geological Survey, recently has given three illustrated lectures before the department of geology and mineralogy of Columbia University on the potash deposits of New Mexico and Texas, the borate deposits in the southwest, and the crystal cavities of the New Jersey zeolite region. He also spoke on "The Potash Mine in New Mexico" before the American Institute of Mining and Metallurgical Engineers and on "Some Fascinations of Mineralogy" before the New York Mineralogical Club.

PROFESSOR ERNST WALDSCHMIDT-LEITZ, director of the institute of biochemistry, Deutsche Technische Hochschule, Prague, will give the Dohme Lectures on April 20, 21 and 22, at 4:30 P. M., at the School of Medicine of the Johns Hopkins University. The titles of his three lectures are: "On the Specificity and Mode of Action of Proteolytic Enzymes," "The Structure of Proteins," "On the Biological Significance of Enzymatic Activation."

THREE Cantor Lectures on recent researches on the nature and function of vitamins will be given by Professor J. C. Drummond on April 18 and 25 and May 2, at the Royal Society of Arts, London.

DR. COLEMAN R. GRIFFITH, associate professor of educational psychology at the University of Illinois, addressed the St. Louis University Sigma Xi Club on March 14 on "Some Studies on Exercise and Fatigue."

THE Sydney Ringer Memorial Lecture at University College Hospital Medical School, London, was delivered by Professor C. R. Harington on March 11 under the chairmanship of Sir Edward Sharpey-Schafer. The subject was "The Nature of the Secretion of the Thyroid Gland."

THE Biological Laboratory at Cold Spring Harbor, Long Island, New York, will inaugurate this summer a new course on plant sociology, which will take the place of field botany. As the name suggests, this course will be concerned with the recognition and description of plant associations and the investigation of their floristic compositions. Professor H. S. Conard will be in charge. Dr. A. J. Grout will conduct work in bryology.

PROMPT action on the part of both the House and the Senate has been requested, as Science Service reports, by the State Department and President Hoover, so that an $85,000 appropriation may be authorized to defray the expenses of the sixteenth session of the International Geological Congress to be held in this country in 1933. The House Committee on Foreign Affairs has already reported favorably on such an authorization. The congress was originally planned for 1932, but failure of the legislative branch of the government to authorize the funds last session caused a postponement. The committee report states: "The committee feels these congresses are very vital to the development of the resources of the world and that matters are discussed which eventually develop into action which means much to the financial condition of the country. . . . It is understood that this geological congress will devote considerable time to the discussion of copper, silver and petroleum."

MANSON HOUSE, the new headquarters of the Royal Society of Tropical Medicine and Hygiene in London, was declared open by the Prince of Wales on March 17.

ACCORDING to the *Journal* of the American Medical Association, the Council of the Royal College of Surgeons of England is presenting a hand-wrought and chiseled silver mace to the Royal College of Surgeons of Australasia. The staff is decorated with a pattern of English roses, Australian wattle and New Zealand ferns, and it is inscribed with the names of the twenty-four members of the council for the present year. The total weight of sterling silver is 189⅛ ounces troy, and the length is 3 feet 10⅜ inches. The mace will be presented to the Australasian body when Lord Moynihan visits Australia this year.

IT is reported that Harvard University will receive an endowment fund of more than $1,000,000 from the estate of the late Nelson Robinson, of New York City. It appears that Mr. Robinson had a life interest in this fund and that the principal will now go to the university.

SCIENCE SERVICE reports that representatives of 21 states have been attending the school for State Sanitary Engineers which the U. S. Public Health Service held at its stream pollution investigations station in Washington. The object of the school, which ended on March 26, was to acquaint these officials with the latest developments in laboratory methods and technique and other problems in their field. During the morning the "men" worked in the laboratories, where expert technicians demonstrated methods and unusual conditions. In the afternoon officers of the U. S. Public Health Service lectured on various problems of interest to sanitary engineers, such as stream pollution, malaria control, milk sanitation, water purification, unusual problems of public water supply brought about by drought, and similar topics. Arrangements for the school were made jointly by Mr. E. S. Tisdale, sanitary engineer of the West Virginia State Department of Health, and Mr. J. K. Hoskins, sanitary engineer of the U. S. Public Health Service in charge of the station. The states represented at the school were: Arizona, California, Connecticut, Idaho, Illinois, Iowa, Kansas, Kentucky, Massachusetts, Minnesota, Missouri, New Hampshire, New York, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Texas, West Virginia and Wisconsin.

THE Field Museum of Natural History has received a large and important collection of plants gathered in Petén, Guatemala, and in British Honduras, made by Professor H. H. Bartlett, of the University of Michigan. The plants are being identified by Paul C. Standley, associate curator in charge of the museum's herbarium.

ACCORDING to the London *Times* the Oxford University Exploration Club is sending an expedition this year to North Sarawak instead of to Arctic Canada, where they worked last year. Mr. C. S. Elton, chairman of the club, reported recently that a biological survey of plant and animal life is to be made. The club is an undergraduate one, backed by experienced senior explorers and travelers. During the last four years expeditions have been sent to Greenland, British Guiana, Lapland and the Hudson Strait. The Sarawak expedition is backed by the university, which has made a small grant towards the cost, and it goes with the permission and approval of the Rajah of Sarawak, who is providing special facilities. Eight or ten members of the expedition are going from England about the end of July, and the leader in the field will be Mr. I. Banks, curator of the Rajah of Sarawak's Museum at Kuching. They expect to return before the end of the year. The district where most of the work will be done is around the Baram River. Camps will be made in the forest and in the mountains, and a special collection of plants will be made and brought back for further study at Oxford.

PLANS are being prepared for a building for the Polar Research Institute at Cambridge, which is part of the Captain Scott memorial. Dr. Seward, master of Downing College, who has himself done scientific work in the Arctic, stated recently that building would probably start about midsummer and should be ready early next year. Money raised as a memorial to Captain Scott was handed over to the University of Cambridge on condition that a Polar Research Institute was founded and that a suitable building was erected within ten years. The institute itself was established seven years ago and has been doing useful work in inadequate surroundings. Now, however, thanks largely to a gift of £4,000 from the Pilgrim Trust, there is enough money to carry out the original condition and erect a suitable building.

Two new primitive areas in the national forests of California have been set aside by Mr. R. Y. Stuart, chief of the Forest Service. These areas are known as the Devil Canyon-Bear Canyon area, 56 square miles in extent and embracing the entire drainage basins of Devil, Bear and Chileno Canyons in the Los Angeles National Forest, and the San Rafael area, 117 square miles in extent and located on the main crest of the San Rafael range in the Santa Barbara National Forest. Both these areas are accessible by trail only, and will be preserved as far as possible in their present wild state. No roads will be constructed and no permanent structures will be allowed except such as are necessary for protection and administration of the forests.

AT the Hôpital St. Louis, Paris, according to the regular correspondent of the *Journal* of the American Medical Association, a large radiologic service has been created that embodies all modern improvements. The minister of public health attended in person the opening of the new service. The institute was erected through the initiative of Dr. Belot, director of the service, who supervised himself all the details of the construction. A thick wall sheathed with sheets of lead insulates completely the roentgen apparatus from the booth occupied by the patients and the operators. The operators control the apparatus from a distance. The floor is entirely insulated by a thick layer of rubber. In addition to numerous dressing rooms for the patients, there are three rooms for radiologic diagnosis. The physician dictates his observations to secretaries, seated in an adjoining room, by means of a microphone and loud-speaker. The roentgenologist is enclosed in a special booth that assures him absolute protection. A powerful generator enables the operator to make roentgenograms of the lung at the rate of one every 2/100 second. Dummy lifts are used to transfer the plates at once to the laboratories on the ground floor, where they are immediately developed and then placed in an electric drier. The radiotherapeutic service comprises ten rooms. The patients are enclosed in a booth and the nurses control the apparatus from without, while they supervise the patient through a small window in the wall. There are two sets of equipment for superficial roentgenotherapy, an apparatus for moderately penetrative roentgenotherapy, and three sets of equipment for high voltage roentgenotherapy with 250 kilowatts. The generators are coils with a constant tension of 30 milliamperes. The Coolidge tubes, standard type, are enclosed in opaque containers. In other rooms are the various types of apparatus for physical therapy: mercury lamps, diathermic devices, arc lamps, and the like; the filing cabinets; in addition, there are assembly and recreation rooms. Foreign physicians who visited the institute at the time of holding of the International Radiologic Congress stated that nowhere else is there an institute so complete and so modern. From the standpoint of capacity, 10,000 patients a year can be given diagnostic examinations and 30,000 patients can receive widely divergent forms of treatment each year.

WE learn from the London *Times* that the Royal Horticultural Society marked its one hundred and twenty-eighth birthday on March 7 by the unveiling of a plaque commemorating the foundation of the society. The plaque was placed on the face of Messrs. Hatchard's building in Piccadilly, and within the shop will be hung an illuminated record. The Horticultural Society of London was founded on March 7, 1804, at a meeting summoned by Mr. John Wedgwood and held in a room of Messrs. Hatchard's. The society received a Royal Charter on April 7, 1809, and in 1861, under the presidency of the Prince Consort, a new Charter was granted and the style and title altered to the Royal Horticultural Society. In 1899 a supplementary Charter was granted to meet the altered conditions, and this in turn was displaced by a new Charter in 1928. The society's first meetings were at Hatchard's. In 1818 it acquired offices in Regent Street, in 1859 in St. Martin's Place, Trafalgar Square, and in 1861 in South Kensington, after the society had taken over the gardens at the site where the Natural History Museum now stands. In 1888 the offices were removed to Victoria Street and the shows held in the Drill Hall of the London Scottish Volunteers. In the centenary year, 1904, the society built its present offices and hall in Vincent Square. In 1928 the growth of the society demanded a new hall, and this has been built in Greycoat Street, close to the old hall, where the office accommodation and library have been brought up to modern requirements. The society has always maintained a garden for the practical side of its work: in its early days at Kensington, then at Ealing, and later at Chiswick. In 1903 Sir Thomas Hanbury gave in trust the gardens at Wisley. The fellowship of the society is now about 27,000.

ACCORDING to regulations approved at a meeting of the faculty of the division on February 18, reported in the *Journal* of the American Medical Association, graduation in medicine eight years after entering college, instead of the present nine years, will be possible at the School of Medicine of the Division of Biological Sciences at the University of Chicago, with the beginning of the spring quarter. The intern year will be included in the eight years. Abolishment of the bachelor of science degree as an admission requirement was also approved. For admission to the medical school, adequate training in physics, chemistry, biology and mathematics is recommended, in addition to a reading knowledge of German or French. After 1933, a reading knowledge of German will be required. It is expected that this preparation will ordinarily be completed in the first year in the division. Selection by the committee on admissions will be based on character, aptitude and scholarship. Evidence of interest and ability in research will commend applicants to this committee. Requirements for the granting of the degree of doctor of medicine, as approved at this meeting, provide that group examinations be abandoned and general departmental examinations be substituted for them. The student will be required to pass a general departmental examination in each department during the quarter in which he completes his work in that department. The requirement of a thesis for graduation is abolished. The degree of doctor of medicine with honors in one department will be given when, in addition to meeting with distinction the requirements for the degree of doctor of medicine, the student has also completed a satisfactory thesis constituting a contribution to knowledge. This degree will be awarded on recommendation of the department and approval of the faculty of the division. The official name of the medical school will be the School of Medicine of the Division of the Biological Sciences.

DISCUSSION

POSSIBILITIES OF NATURAL RADIATIONS FROM THE GREAT BEAR LAKE PITCHBLENDE DEPOSITS ON GENE MUTATIONS

THE possibility of radiations from the earth in producing gene mutations was indicated by the recent work of Babcock and Collins[1] in California and by Hanson and Heys[2] in Missouri. This prompted the writer to point out the possibilities of the recently discovered pitchblende deposits at La Bine point in the Echo Bay region of Great Bear Lake in the Northwest Territories, Canada.

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[1] E. B. Babcock and J. L. Collins, "Natural Ionising Radiation and the Rate of Mutations," *Nature*, 124: 227-228, 1929.

[2] F. B. Hanson and Florence Heys, "A Possible Relation between Natural (Earth) Radiations and Gene Mutations," SCIENCE, n.s. 71, 1828, 43-44, 1930.

The former compared the rates of occurrence of sex-linked lethal mutations in *Drosophila* in a street-car tunnel in San Francisco, where the natural ionizing radiation was fully twice as great as the radiation in their laboratory at Berkeley. The difference in the rate of occurrence of lethal mutations in the tunnel and in their laboratory, which was 2.5 times the probable error, although probably not statistically significant, is indicative.

The latter, working independently of Babcock and Collins, arrived at a somewhat similar conclusion. After unsuccessfully searching with an electroscope in the Ozark caves and lead mines in Missouri for a location with sufficient increase of ionization over that of the laboratory, they finally utilized an abandoned Carnotite mine in Colorado. The radiation in this mine was 0.39 times as intense as that from one mg of radium when the rays were passed through a 0.156 inch lead filter. Male *Drosophila* flies were exposed *for 40 hours in this mine. It was found that* the difference in the occurrence of gene mutations between tests and controls was 2.09 times the probable error. Although the results of these two independent experiments are probably not statistically significant, they would seem to suggest that more definite results might be obtained from more strongly ionizing radiations.

From electroscopic tests of eight samples of pitchblende from La Bine Point, Echo Bay, Great Bear Lake, N.W.T., Spence,[3] mineral technologist, Department of Mines, Ottawa, found that the uranium oxide content ranged from 27.88 to 83.90 per cent.; the equivalent range of radium content would thus be approximately from 70.79 to 213 milligrams per ton. Complete chemical analysis of two samples are also given in tabular form. The intensity of radiation from these outcrops[4] of pitchblende would undoubtedly be much greater than the intensity of radiation in either an abandoned Carnotite mine in Colorado or a street-car tunnel in San Francisco.

Considering the work mentioned, it has occurred to me that biologists might profitably investigate the Great Bear Lake pitchblende deposits from the viewpoint of observing gene mutations produced under conditions there. Evidence of this in the flora and fauna indigenous to the district, which includes species of Picea, Betula, Alnus, Ericads, mosses, liverworts and lichens, as well as numerous insects, might be observed in addition to exposing introduced biological entities, such as insects, mosses, fungi and other plants of known genetic constitution, to the action of these natural radiations.

The inaccessibility of the field, some 700 miles north of Edmonton, practically only accessible by airplane, and the lack of the necessary funds and material for this type of investigation has practically placed this very interesting possibility beyond the scope of the writer. No doubt this field would yield some very interesting data in regard to the rôle of natural radiations as a factor in the evolution of species by furnishing hereditable variations upon which the forces of nature could act.

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EDMONTON, ALBERTA

POSSIBILITIES OF SECONDARY POISONING OF BIRDS AND MAMMALS

IN the winter of 1915, during jack-rabbit poisoning work in Lake County, Oregon, a coyote in the characteristic position of strychnine poisoning was found dead at a haystack. Portions of mutilated carcasses of rabbits that had been poisoned were lying near-by. In most cases the stomach and intestines were the only parts of the rabbit left untouched, but occasionally these also had disappeared. The stomach contents of the coyote found dead were examined and found to contain the stomach of a rabbit together with the contents. It is not common for a coyote to eat the viscera of rabbits. This was a case of direct poisoning from swallowing the poisoned bait in the rabbit stomach rather than secondary poisoning from eating strychnine in the flesh.

The lean meat of several rabbits that had been poisoned with strychnine was fed a dog and some chickens without producing any ill effects.

Hawks have often been observed to eat ground squirrels and prairie dogs so poisoned, without apparent ill effects.

Indians on some of the Indian reservations have been reported to have eaten ground squirrels poisoned with strychnine, without any unpleasant after effects.

Reports have been received that occasionally a dog has died suddenly after eating the bones of a poisoned rabbit that had been exposed for months to the weather. Laboratory analysis of such bones has shown minute quantities of strychnine present in them. Before being killed, however, very few rabbits ingest sufficient strychnine that enough would be deposited in the bones to kill a dog.

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[3] Hugh S. Spence, "Radium-bearing Minerals from Great Bear Lake, North West Territories," Mines Branch, Dept. of Mines, Ottawa Memorandum Series No. 48: 1–4, 1931.

[4] Hugh S. Spence, "Occurrences of Pitchblende and Silver Ores at Great Bear Lake, N.W.T.," Mines Branch, Dept. of Mines, Ottawa Memorandum Series No. 51: 1–6, 1931.

After eating ground squirrels affected with bait materials poisoned with thallium sulphate, a number of coyotes have been found dead or having the symptoms of thallium poisoning. A small percentage of the squirrels when affected with thallium will sit at the entrance of their burrows in a stupor, and the coyotes easily catch them and eat the whole carcass. If they happen to catch one that has eaten a large quantity of grain within twelve hours, they may obtain some of the thallium on the grain. This would greatly reduce the number of squirrels they would have to eat to obtain a lethal dose. The number of squirrels in this condition, or of squirrels that die on the surface when thallium is used, is small in comparison with the original number of squirrels. Rarely skunks have been found dead that were suspected of having been killed by secondary poisoning on areas treated for ground squirrels with thallium-poisoned grain. That so few carnivores are affected by thallium in rodent control operations is probably due to the large number of poisoned rodents they would have to eat to obtain a lethal dose, and the difficulty in securing the number that would be required.

Very seldom has a bird of prey been found dead on or in the vicinity of areas from which the squirrels had been removed with thallium. On the Peckham Ranch, Santa Cruz County, California, on March 13, 1927, an eagle was observed that showed symptoms of thallium poisoning. Of several eagles that were feeding on the same area it was the only one affected and was found dead on the 21st.

To obtain some definite information under controlled conditions on the secondary poisoning of hawks with strychnine and thallium, a study of their resistance to these poisons was made at the Control Methods Research Laboratory, at Denver, Colorado. Early in July of 1928 a young Swainson's hawk was obtained and held in a large cage until December, 1928. Observations of the hawk's habits of feeding revealed the fact that it would readily take two medium-sized wild rats at a feeding, but that any number in excess of two would usually be killed and saved for future use. Thirteen small rats were consumed, however, in a two-day period. Medium-sized rats were considered those weighing 150 to 300 grams; small rats 40 to 125 grams.

In the period from December 12 to 17, this hawk was continually fed wild rats that had been killed with thallium iodide. Ten rats were eaten, and these ten rats contained 42.70 mg of thallium as the iodide. As the hawk weighed 1.24 kg this represents a dose of 34.43 mg/Kg. No symptoms of poisoning were noted.

Then on the successive days of February 13 and 14, 1929, the hawk was fed a total of 13 rats, which contained 153.37 mg thallium as the sulphate. The bird weighed 1.36 kg, so this dose was 113.00 mg/Kg. This showed no symptoms of poison.

On May 27, a rat was injected with 100.00 mg of arsenic as the trioxide and fed to the hawk. For two days after this dose of 73.70 mg/Kg the bird was somewhat listless and had no appetite, but by the 30th of the month normal appearances had returned. So on June 13 a rat carrying 200.00 mg of arsenic was given to the hawk. This dose of 147.40 mg/Kg failed to produce any toxic response at all.

On June 19 a rat was injected with 500.00 mg of strychnine as the sulphate, and fed to the hawk. It was taken rather slowly, but all was gone on the morning of the 20th. This was a dose of 368.00 mg/Kg of strychnine, and the hawk was in evident distress most of the day. The symptoms manifested, however, were confined to difficult breathing, stiff legs and extreme nervousness.

Regardless of this condition, the hawk's appetite was still good on the 20th, and it ate a rat that had been killed by an injection of 300.00 mg. of thallium as the sulphate. This was a dose of 220.00 mg/Kg, since the hawk had been practically stationary in weight for some time. On the morning of the 21st, the bird's appearance was entirely normal. On the 22d, it took a rat readily. The first signs of illness appeared on the 23d. On the 24th the bird was almost comatose with eyes closed and the wing drooped.

On the 25th, the hawk's condition was improved, and ate a new-born wild rat. A relapse occurred on the 26th, but the appetite was still good and three infant rats were eaten. By the 27th the bird was unable to stand. Posterior paralysis was well developed. No appetite. Condition was unchanged during the day of the 28th. Hawk died in asphyxial spasm at 9:15 A. M. on the 29th.

During its experimental career, this hawk survived 34.43 mg/Kg and 113.00 mg/Kg thallium; 73.70 mg/Kg and 147.40 mg/Kg arsenic; 368.00 mg/Kg strychnine. And finally lived for 9 days after a dose of 220.00 mg/Kg of thallium.

These figures indicate how extremely unlikely it would be to kill a hawk of this kind by secondary poisoning under field conditions. An ordinary small mammal, such as a ground squirrel, weighing from 1/4 to 1/3 Kg is killed by 3 to 10 mg of Strychnine; 10 to 25 mg arsenic; or 8 to 15 mg of thallium. Assuming then that the mammal had eaten the larger quantity of poison listed, a hawk like the one tested could eat more than 50 squirrels that had been killed with strychnine; more than 8 that had been killed with arsenic, and about 20 that had died from the effects of thallium, providing it did not obtain any of the ingested poisoned grain.

With this resistance to strychnine the hawk would be practically immune to danger from secondary poisoning from such a toxic agent.

These experiments indicate that the bird would be forced to live entirely for about three weeks on mammals dying from thallium to obtain a lethal dose. This estimate is made disregarding the rate of elimination of poison that would be made by the mammal, which factor should double the number of animals needed to provide a lethal dose for the bird.

These results in laboratory experiments lead to the following conclusions:

Arsenic has no great secondary poisoning hazard, and is too erratic in its results to be a good rodent poison, consequently it is not used in large field-control operations.

Strychnine presents no danger of secondary poisoning to hawks.

Thallium is apparently more hazardous, but even this cumulative poison can kill hawks only in extraordinarily large doses, unlikely to be obtained under field conditions.

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SPREAD OF BROAD FISH TAPEWORM OF MAN

THE finding of *Diphyllobothrium latum* (Linn., 1758), the broad fish tapeworm of man, in Oklahoma should be of interest to parasitologists. It is known that this species was brought to the United States by the Swedes and Finns who settled in Minnesota and North Dakota, where the proper intermediate hosts for its development abound. Hegner, Root and Augustine[1] write: "In the United States *Diphyllobothrium latum* has been considered a rare parasite occurring only in emigrants from European endemic centers. However, a number of indigenous infections have been reported recently from Minnesota, Illinois, Indiana, Michigan and Massachusetts." The above-mentioned states are all in the northern tier of states. The occurrence of this tapeworm in Oklahoma shows a wider distribution for the species.

Recently a thirty-one-year-old laborer called at the Oklahoma Medical School Hospital clinic for treatment. He stated that he believed he had a tapeworm because he recognized the signs and that he knew people got them from eating dried fish in the old country, as he had done. He stated that he was a native of Finland and has been in America fifteen years, coming to Oklahoma three months ago from Louisiana. This is interesting, because the tapeworms taken from him must have had a length of life of over fifteen years, provided of course that he became infected in his native land. Riley[2] stated a Swedish woman was definitely known to carry the infection for thirteen years.

Upon examination he was found to have numerous ova in the stool, to have bloody diarrhea, to be very anemic and weak, with attendant colicy pains. These pains he claimed doubled him up and kept him from work. Dr. A. D. Danielson treated him with oleoresin of aspidium and salts. At the first treatment twelve feet of proglottids was obtained. Later fifteen to twenty feet was obtained. All the segments showed the characteristic grayfish color and coiled brown uterus centrally located. By careful search two heads were found. These were unarmed and had two bothria or slit-like suckers. Upon the patient's release, "feeling much better," he was told to come back in two months to be checked.

As this host came from Finland not more than fifteen years ago, it is evident that carriers are still actively transporting this parasite across the ocean and spreading it farther in the United States, and that the migration of Finns, and perhaps Swedes, in search of work in new areas is a large factor in its spread.

The danger of this species becoming indigenous to the southern states seems remote, due to the absence of cold water lakes and proper intermediate fish hosts. The possibility remains, however, that *D. latum* may adapt itself to different intermediate hosts from those now known for it and hence become endemic in new areas.

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DISCOVERY OF CONODONTS IN THE PHOSPHORIA PERMIAN OF WYOMING

DURING the summer of 1931, the Phosphoria formation along the east front of the Wind River Mountains, Wyoming, was examined for microfossils. The Phosphoria is Pennsylvanian and Permian in age, the boundary coming below the Pustula member. This member contains a bed of low-grade rock phosphate which weathers rapidly into rounded grains. About 1 per cent. of these grains were found to be conodonts. This is the highest known stratigraphic occurrence of the conodont group.

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[1] R. W. Hegner, F. M. Root and D. L. Augustine, "Animal Parasitology," 731 pp. New York, 1929.

[2] Wm. A. Riley, "The Longevity of the Fish Tapeworm of Man, *D. latus*," *Jour. Parasitol.*, 5: 193, 1919.

The Phosphoria types are peculiar and are apparently senile specializations of a rapidly declining group. They seem to bear the same relationship to other conodonts that the late Cretaceous ammonites do to other ammonoids and that Silurian and Devonian trilobites do to other trilobites. There are at least two types of ribbed spoon-like teeth and one type of plate-like tooth with longitudinal lines of denticles. Simple conical forms are abundant. The species will be described and figured in a later paper.

C. C. BRANSON

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ACADEMIC FREEDOM IN ITALY

NEXT summer the International Physiological Congress is scheduled to meet in Rome. In this connection I wish to call the attention of the members of the Federation of American Biological Societies, who are members of this congress, to the official edict issued by the Italian government on October 8, 1931, compelling all professors in Italian universities to swear allegiance to the Fascist régimo. As announced in *School and Society* for January 9, eleven university professors out of 1,225 have refused to take this oath of allegiance.

I wish to propose to the members of the Federation of American Biological Societies for the coming meeting in Philadelphia in April the consideration of refusing to attend the International Congress of Physiology in Rome August next unless this brutal and defiant attack on academic freedom on the part of the Italian government is rescinded.

(*Signed*) A. J. CARLSON

DEPARTMENT OF PHYSIOLOGY,
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MARCH 4, 1932

SCIENTIFIC BOOKS

The Universe of Modern Physics. By MAX PLANCK. W. W. Norton and Company, Inc., 1931.

THE revolution of thought which had its inception in two physical theories, relativity and quantum mechanics, has swept over larger and larger fields of human concern. It has drawn into scientific controversy, and caused a revision of, some of the concepts that were considered to lie at the very basis of philosophical and physical thought. In the midst of the multifarious and conflicting attempts of reformulation we hear the voice of Planck, the man whose work was largely responsible for the abandonment of classical reasoning in physics. He addresses not the comparatively few who work in the special fields of theoretical physics, but all those who have an interest in the basic problems of physical reality. And his message is certain to be received with greatest attention.

Physicists are entirely too prone to forget the relations between their science and the fundamental issues of epistemology; indeed they frequently neglect to apply the test of logical consistency to the concepts which compose their theories. Planck's aim is to clarify these matters. He starts by stating the goal of physics, which he defines as the apprehension of true reality, a goal which is admittedly unattainable but acts as a guiding ideal in scientific investigations. Reality, in Planck's analysis, is more than the mere phrase it appears to be in many similar treatises: the world of reality is definitely set aside as one of three, the other two being the world of sense and that of physics. The latter is a deliberate hypothesis and is subject to change, while the world of reality is immutable.

The discussion of these metaphysical matters is followed by a lucid exposition of relativity and the quantum theory, particular emphasis being placed upon those points at which they break away from the more common habits of thought. Planck's comments on Heisenberg's principle of uncertainty are very noteworthy indeed, for he makes a point which is too often overlooked in the numerous illustrations of this principle: It "has nothing whatever to do with any measurement," but derives its validity only from the wave nature of matter. Determinism is redefined, and its premises are then shown to apply to wave mechanics, so that uncertainty can not be said to be contradictory to determinism. Nevertheless, there is an important distinction between determinism in classical physics and in quantum physics. Classically, the configuration of objects was governed by definite laws; in quantum mechanics complete determination fixes the state of material waves. This situation is not opposed to strict determinism; it merely renders considerably looser the relation between the physical world and the world of sense.

Causality, complete physical lawfulness are in Planck's opinion the bases of physical science. He regards causality as a category which is given *a priori*, much in the Kantian sense. The definiteness of his statements on this controversial point is truly pleasing, and it is to be hoped that the soundness of the author's view will penetrate the mist which still beclouds this important problem. On the basis of the supposition of lawfulness the physicist proceeds to erect his science, and his efforts are governed very largely by working hypotheses, whose rôle and importance are discussed. Interesting examples taken from the history of physical thought illustrate the making of physical theories. After discussing the genesis of physical laws Planck examines their contents. He finds that, from this point of view, all laws can be divided into two main groups: those governing reversible and those governing irreversible processes. While it is impossible on logical or empirical grounds to decide whether one type of law is derivable from the other, Planck wishes to uphold the postulate that all laws are ultimately of a dynamical character, this being essential for the healthy development of physics.

Attempts have frequently been made to establish freedom of will on the basis of physical uncertainty. Planck shows convincingly how unnecessary such endeavors are, for he proves with his usual clarity that "human free will is perfectly compatible with the universal law of strict causality." In concluding he discusses some of the difficulties with which modern theories are still confronted, and points out the value which might arise from a coordination of scientific and philosophic endeavors.

The book contains in its 114 pages not only a considerable amount of valuable information accessible to those not specifically versed in science but it presents the views of a man who has left his permanent imprint upon the subject of which he speaks. Minor technical errors are only too likely to appear in a book of such broad perspective; there seems to be one on page 31 where the author, speaking of points at which the potential energy exceeds the total energy, is apparently referring to states where the total energy is *negative*. Some might find, too, that space should have been given to Dirac's more recent theories—but all such criticisms would seem pedantic.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFICATION OF THE OSBORNE-MENDEL SALT MIXTURE CONTAINING ONLY INORGANIC CONSTITUENTS

IN a salt mixture used in compounding synthetic diets for experimental animals, it has seemed to us to be desirable to use purely inorganic salts because of the possibility that the citrates and lactates, commonly used in salt mixtures, may contain unsuspected vitamins. The salt mixture given below, in addition to fulfilling the requirement as to purely inorganic sources, is easily prepared from readily available C. P. chemicals with very little grinding and does not cake on standing. Moreover, it contains the inorganic radicals of Osborne and Mendel's milk salts to give in 1 kilogram of completed ration essentially similar amounts of the necessary constituents that this last would give in the proportion recommended, and thus should be equivalent for feeding purposes.

For convenience in comparing the present salt mixture with that of Osborne and Mendel,[1] as well as with McCollum's No. 185,[2] and Hawk and Oser's[3] recently suggested mixture, the 4 mixtures have been calculated to a 1 kilogram finished salt basis (Table I). As different proportions of salt mixtures in the

TABLE I

INGREDIENTS TO GIVE 1 KILOGRAM SALT MIXTURE

	O. and M.[1] grams	McC. No. 185[2] grams	H. and O.[3] grams	Suggested grams
NaCl		46.7	77.41	105.0
KCl			125.29	120.0
KH_2PO_4				310.0
$Ca_3(PO_4)_2$				149.0
$CaCO_3$	310.2		68.90	210.0
$MgSO_4$ (anhydr.)		72.0	38.50	90.0
$FePO_4 + 4H_2O$				14.7
$MnSO_4$ (anhydr.)	0.182		0.161	0.20
$K_2Al_2(SO_4)_4 + 24H_2O$	0.0564		0.0925	0.09
$CuSO_4 + 5H_2O$				0.39
NaF	0.571		0.508	0.57
KI	0.0460		0.0414	0.05
$NaH_2PO_4 + H_2O$		93.8		
K_2HPO_4		257.7	219.72	
$CaH_4(PO_4)_2 + H_2O$		146.0	113.25	
Ferric citrate + $1\frac{1}{2}H_2O$	14.59	32.0	13.00	
Ca lactate		351.8		
Ca citrate			309.67	
$MgCO_3$	55.67		33.43	
Na_2CO_3	78.78			
K_2CO_3	325.1			
H_3PO_4	237.4			
HCl	122.8			
H_2SO_4	21.16			
Citric acid + H_2O	255.4			

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[1] T. B. Osborne and L. B. Mendel, *J. Biol. Chem.*, 37, 557, 1919.

[2] E. V. McCollum, O. S. Rask and J. E. Becker, *J. Biol. Chem.*, 77, 753, 1928.

[3] P. B. Hawk and B. L. Oser, SCIENCE, 74, 369, 1931.

ration are recommended by these investigators, a comparison is also given (Table II) of the percentage of the inorganic radicals in a diet prepared with the prescribed proportions of salt mixture to ration.

TABLE II

PERCENTAGE OF RATION

	O. and M.[1] per cent.	McC. No. 185[2] per cent.	H. and O.[3] per cent.	Suggested per cent.
Salt mixture	4.0	3.7	4.4	3.5
Na	0.137	0.126	0.134	0.145
K	0.737	0.427	0.721	0.533
Ca	0.496	0.256	0.489	0.500
Mg	0.064	0.054	0.0766	0.0636
Fe	0.0120	0.0243	0.0118	0.0129
Mn	0.000265		0.000258	0.000255
Cu				0.000348
Al	0.000013		0.000023	0.000018
PO_4	0.920	1.169	0.906	1.098
SO_4	0.083	0.212	0.135	0.251
Cl	0.478	0.105	0.468	0.423
F	0.00103		0.00101	0.000903
I	0.000144	*	0.000144	0.000134

* Iodine in drinking water.

The suggested mixture has been used in essentially the present form for several years in this laboratory. Copper has added recently in accordance with the findings of Waddell, Steenbock and Hart[4] and Elvehjem and Hart.[5]

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A NEW KAHN ANTIGEN MIXER

THE proper mixing of the Kahn antigen with salt solution in order to obtain a stable and uniform emulsion is still something of a problem, notwithstanding the improved mixers available on the market.

In this laboratory and in that of Agnew State Hospital we have used a mixer which possesses definite advantages over all others and which is inexpensive to make. It is nothing more than a Hatschek emulsifier in miniature. Its operation is simple.

The materials used are as follows:

(1) A specimen vial ⅝ inch inside diam. by 2¾ inches long

(2) 1 rubber stopper No. 3 with 2 holes.

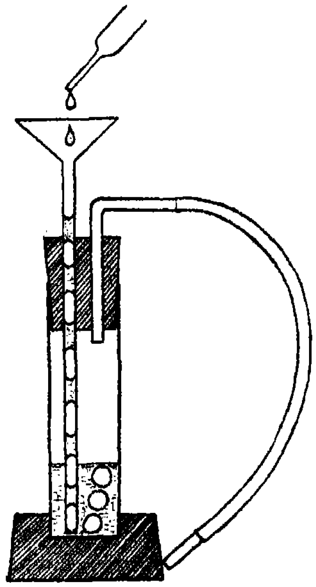
(3) A 1 inch funnel with a stem 4 inches long.

(4) A 1½ inch right angle glass tube, ¼ inch inside diam.

(5) A piece of rubber tubing 9 inches long by ⅜ inch diam. with glass tubing mouth-piece.

The end of the funnel is heated until the hole is ½ mm. in diameter. When inserted through the rubber stopper and the vial closed the funnel stem should almost touch the bottom. For greater stability the base of the vial can be held in a No. 9 rubber stopper.

The antigen is put into the vial first. After the stopper is replaced, gentle suction by mouth or otherwise is applied by means of the rubber tube connected with the right angle glass tube. This causes bubbling through the antigen. Now the salt solution is poured into the funnel one drop at a time—say 2 or 3 drops per second. The entrapped air between the drops does the mixing of the salt solution with the antigen in the vial. If mechanical suction is used and also a dropping funnel it is possible to reproduce the mixing exactly each time and standardize the emulsion with great accuracy; something almost impossible with the mixers in general use. Since this mixer has been in use, a marked decrease in doubtful determinations has taken place.



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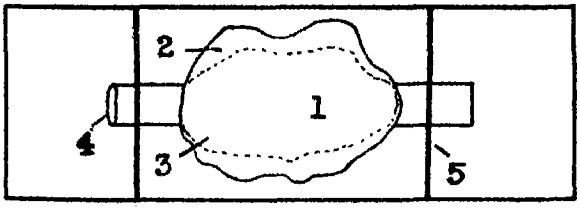
[4] J. Waddell, H. Steenbock and E. B. Hart, *J. Biol. Chem.*, 84, 115, 1929.

[5] C. A. Elvehjem and E. B. Hart, *J. Biol. Chem.*, 84, 131, 1929.

A SIMPLE METHOD FOR THE STUDY OF LIVING FRESH-WATER SPONGES

THE pores, oscula and superficial canals of fresh-water sponges can be readily seen with the aid of a good lens. The many branching canals which extend throughout the sponge body, the flagellated chambers and the cellular structure, however, can not be easily studied on the living sponge. All these structures may be demonstrated by a very simple method.

If a small healthy sponge or a portion of a larger one is placed on a glass slide at the bottom of a dish of pond water (water 2 to 3 inches deep) it will soon adhere to the slide and grow out on the surface of the glass as a thin incrustation. If the sponge used is growing on the stem or leaf of a water plant it will tend to float. In this case the stem (4) or leaf should be tied to the glass slide by pieces of thread (5), as shown in the diagram. The slide should be changed to fresh pond water every twenty-four hours. Generally a thin marginal membrane, attached to the slide around the sponge mass, appears within twenty-four hours. By the end of the second day a wide area (2, 3) of sponge tissue has grown from the original mass, and by the end of the third day large canals are easily seen in this area without the aid of a lens. If the sponge used is small, all the tissue deserts its original substratum and moves out on the slide. If the original sponge is large the thick portion (1) may be carefully cut away without injury to the encrusting mass. The slide may then be taken from the dish, covered with a thin cover glass, and studied with the oil immersion objective if necessary. At the periphery of the mass there is a thin marginal membrane (2) in which the various types of amoeboid cells may be more easily studied. The inclusions of these cells are more clearly seen if a very dilute solution (1–10,000) of some vital stain such as Nile blue or methylene blue is added. In the thicker part of the incrustation (3) the flagellated chambers, with the actively beating flagella are seen. These preparations may be studied for long periods, provided water is added at the edge of the cover glass quite often. The cover may be removed without injury to the sponge and the slide returned to the pond water for future study, or the specimen may be fixed on the slide and a permanent stained mount prepared.



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SPECIAL ARTICLES

INSECTS AS VECTORS OF YELLOW DWARF OF ONIONS[1]

FOR the past few years onion growers in the vicinity of Pleasant Valley, Iowa, have been greatly concerned over a virus disease of the onion, known locally as "yellow dwarf," and the means by which it is disseminated under field conditions. During the season of 1928 losses from this malady amounted to as high as 95 per cent. of the crop in some plantings. At that time field observations made it quite evident that some agent, perhaps an insect, was responsible for the spread of the disease. Since 1928 yellow dwarf has not been so prevalent in the fields nor so severe in its attack, a result largely due to the practice of using only disease-free sets. Such sets were secured either from localities where yellow dwarf had never appeared or from fields within the infected area free or almost free of the disease as determined by indexing. During this period, however, it remained constantly evident that there was dissemination in the field by vectors.

While making a survey of the insect pests attacking onions in Iowa the writers, aside from studying the forms that might be called of primary and secondary importance, have given attention to several species which are not able normally to subsist on onion, but which, nevertheless, occasionally or only incidentally feed upon it. Although many tests have been made with members of the former groups it has from the first seemed probable that in the latter would be found the vectors of the virus.

Yellow dwarf, or "crinkles" as it is sometimes called, is so named because of its most characteristic symptoms—*viz.*, yellowing and stunting of the plant, accompanied by drooping and frequently by crinkling and chlorosis of the leaves. Under certain conditions the symptoms may be completely masked until after the bulbs have undergone a rest period and then have been regrown. Such plants may serve as a means of carrying the disease from season to season and as a source of infection to insect vectors. The disease is not tranmitted through the seed.

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[1] Journal Paper No. B40 of the Iowa Agricultural Experiment Station.

In the insectary at Ames yellow dwarf has been transmitted to a large number of onion plants by three species of aphids[2]—the bean aphid (*Aphis rumicis* Linn.), the corn leaf aphid (*Aphis maidis* Fitch) and the apple grain aphid (*Rhopalosphium prunifoliae* Fitch), and by the six-spotted leaf-hopper (*Cicadula sexnotata* Fall.). Observations indicate that the bean aphid and the corn leaf aphid are responsible for a large percentage of the transmission of the disease. These two plant lice are quite common in the fields at Pleasant Valley and feed very readily on the leaves of the onion. Moreover, cage experiments with these two forms gave the highest percentage of transmission. The apple grain aphid does not feed as readily on the onion and only a few cases of transmission were secured with it, as was also the case with the six-spotted leaf-hopper. Although the latter is very common in the fields and readily feeds upon the onion plant further experimentation is needed to substantiate its rôle as an important vector of yellow dwarf.

For the experiments the different species of aphids were reared in separate rooms on some of their preferred hosts. From eight to twelve individuals of a species, after having been confined on a diseased plant for twenty-four hours, were transferred to disease-free plants in individual cages. When so confined on an onion, practically all the aphids died within a period of three to six days. In more than 200 definite transmissions the symptoms of yellow dwarf appeared on an average of seven to twelve days after the initial exposure to feeding by viruliferous lice. Plants thus infected were then successfully used as sources of inoculum to infect other plants. As controls, plants not exposed to the feeding of lice and plants supporting lice which had not been exposed to a source of inoculum were used. The symptoms of the disease have not yet appeared in any of these control plants, whereas in those exposed to aphids which had previously fed on diseased plants a high percentage of infection has resulted. In fact, in more than 100 tests during the month of February, 1932, 91 per cent. of the caged plants showed typical disease symptoms within 12 days.

The viruliferous aphids were confined on seedlings, sets and mother bulbs in various types of cages. In a number of tests the vectors were limited to small portions of an individual leaf, whereas in others they were permitted to run at large over a caged plant and to feed upon any part of this plant. Regardless of the portion of the plant upon which the aphids had been confined the first visible evidence of the disease always made its appearance in the new shoots. Frequently, in the larger onions no indications of the disease were ever apparent in older leaves upon which the insects had been confined, whereas the new shoots of these plants disclosed typical symptoms of yellow dwarf.

C. J. DRAKE
H. M. HARRIS
H. D. TATE

THE PRE-OLIGOCENE STRATIGRAPHY OF PORTO RICO

LATE in 1930 Mr. James Thorp, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, discovered fossils in moderate numbers in the older rocks of Porto Rico. The several localities found are situated in the central part of the island at points where fossils had not previously been reported. The discovery was followed by an energetic search, in which Dr. N. L. Britton, chairman of the Scientific Survey of Porto Rico and the Virgin Islands, Mr. W. D. Noble, of San Juan, and Mr. Thorp were the chief participants. In March and April, 1931, at the invitation of Dr. Britton, the author examined the fossiliferous localities, supplementing the collections already made. Pending detailed studies of the material, a preliminary statement of its stratigraphic significance is herewith offered.

The collections contain approximately twenty species in a sufficiently good state of preservation for specific description, and there are a dozen additional forms which give some promise of ultimate identification. The majority of the species either are new or are closely related to, and perhaps identical with, species known in the older rocks of other Antillean islands. The assemblage is dominantly molluscan, but it also contains one or two species of algae, at least three of corals, one echinoid and one or two belonging to the arthropods.

The rarest specimen is that of an ammonite, the third thus far discovered in Porto Rico.[1] With the two ammonites previously found, it has been referred to Dr. John B. Reeside, Jr., of the U. S. Geological Survey, who has kindly submitted the following opinion:

> The small specimen with strong sculpture (Fig. 6, right)[1] seems to me a *Barroisiceras* very close to *B. haberfellneri* (von Hauer) in the strict sense (*cf.* Grossouvre, Les ammonites de la Craie superieure, pl. 1, fig. 1a, 1b). The large fragment [among the recent discoveries] seems to be a *Parapuzosia* close to *P. corbarica* (Grossouvre). I do not know any forms like these in the Lower Cretaceous [but] think them to indicate middle Upper Cretaceous age—Coniacian of the European nomenclature.

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[2] Aphidae determined by Dr. F. C. Hottes.

[1] H. A. Meyerhoff and I. F. Smith, "The Geology of the Fajardo District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. II, pp. 224–225 and Fig. 6, 1931.

Among the other molluscan types the rudistids are at once most numerous and most significant. They are present in the majority of the newly discovered faunules, usually dominating them. The specimens do not appear referable to any described species but have much in common with the genus *Barrettia,* which characterizes the Upper Cretaceous of Jamaica. Several of the other molluscs are also related closely to Jamaican, Saint Thomas and Saint Croix forms of Upper Cretaceous age.

Fossils are not abundant in the older rocks of the Antillean islands, and this collection is larger and more varied than any other thus far reported. Its discovery promises ultimately to settle the differences of opinion that exist regarding the age of the pre-Oligocene rocks of Porto Rico,[2] and the facts already established warrant the following conclusions:

(1) The claim of E. T. Hodge[3] that the stratified rocks situated in the center of the island near Aibonito are Comanchean must be set aside. The specimen identified by Dr. Reeside as *Barroisiceras aff. habnerfellneri* was found in rocks which Hodge assigned to the Comanchean, and a reexamination of the unconformity which he postulated between the "Barranquitas-Cayey" shales of assumed Lower Cretaceous age and the Upper Cretaceous "Sierra de Cayey" conglomerates has shown the two formations to be clearly intergradational.

(2) Upper Cretaceous rudistids occur profusely in the "Rio Jueyes series," which, on the basis of a single specimen referred to the Eocene species *Venericardia alticosta,*[4] Hodge considered to be early Tertiary and Maury dated as Middle Eocene. Mr. Thorp and the writer visited the reported *Venericardia* locality and obtained a collection of rudistids from it.

(3) G. J. Mitchell[5] resolved Hodge's "Coamo Spring limestone," another postulated Eocene horizon, into two calcareous members, the Guayabal and Coamo tuff limestones, both of which he found to contain Upper Cretaceous rudistids.

(4) Mitchell[6] has demonstrated that Hodge's "Rio Descalabrados series," also assigned to the Eocene, is composed essentially of strata belonging to the "Rio Jueyes series" and Coamo Spring limestone," repeated in consequence of folding. Its limestone members contain Upper Cretaceous rudistids.

(5) The possible equivalence of the Corozal limestone and the Upper Cretaceous La Muda limestone has already been pointed out.[7] No additional support can be given that suggestion at present, but a study of the fauna of the Corozal limestone has demonstrated its Upper Cretaceous affinities.

Thus, nearly all the evidence adduced in arguing the presence of Lower Cretaceous and Eocene strata among the older rocks of Porto Rico has been contradicted by the discoveries of the past six years; and Matley and Earle's opinion that pre-Mesozoic materials are present in Porto Rico and the Virgin Islands is without foundation, other than the physical appearance of some of the rocks. The paleontological and stratigraphic data now at hand, although incomplete, indicate that all the ancient sediments and associated volcanic and intrusive igneous rocks are Upper Cretaceous, not only in Porto Rico, but also in the Virgin Islands.

HOWARD A. MEYERHOFF

MAYAGÜEZ, PORTO RICO

THE DEPENDENCE OF PHYSICS ON THE MATHEMATICAL PREPARATION

AT the beginning of last school year a number of questions in mathematics were prepared by the author to be given to the students of elementary physics at various institutions. The object of giving the test was to find out what correlation, if any, there is between the mathematical preparation of the student and his successes in the course of physics that he is about to take.

Some work of this kind was done at the University of Florida in 1929. The students of elementary physics were given an examination in the essentials of arithmetic and algebra, and the grades made in mathematics were later compared with those made in physics. As the correlations proved to be very high, it seemed worth while to ascertain this correlation on a larger scale by inviting the cooperation of a number of institutions in administering the necessary tests.

The institutions who cooperated in this enterprise were Cornell University, University of Virginia, Oberlin College, Virginia Polytechnic Institution, University of Richmond, University of West Virginia and Bowdoin College. The tests in mathematics were given at the beginning of the school year 1930-1931. The grades of the students made later in physics were sent to the author, and the results about to be presented were obtained from these reports.

---

[2] *Cf.* C. A. Matley and F. Higham, "The Basal Complex of Jamaica, with Special Reference to the Kingston District." *Quart. Jour. Geol. Soc.*, Vol. lxxxv, pp. 472 and *ff.;* also pp. 490–491, 1929; C. J. Maury, "Porto Rican and Dominican Stratigraphy," SCIENCE, n.s., 70: 1825, 609, 1929; H. A. Meyerhoff, "The Pre-Oligocene Stratigraphy of Porto Rico," SCIENCE, n.s., 71: 1838, pp. 322–323, 1930; C. J. Maury, "Correlation of Antillean Fossil Floras," SCIENCE, n.s., 72: 1862, pp. 253–254, 1930; H. A. Meyerhoff and I. F. Smith, *op. cit.*, pp. 219–229, 1931.

[3] E. T. Hodge, "The Geology of the Coamo-Guayama District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, pp. 138, 192–193, 1920.

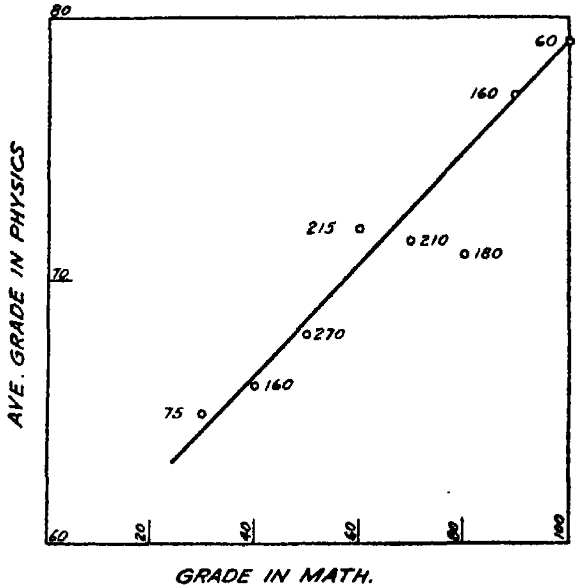
[4] This specimen can not be found, and it is therefore impossible to verify the identification.

[5] G. J. Mitchell, "The Geology of the Ponce District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, 255–257, 1922.

[6] *Ibid.*, pp. 255–257; plate VI, section H-H′; geologic map. *Cf.* Hodge, *op. cit.*, pp. 161–164 and geologic map.

[7] H. A. Meyerhoff and I. F. Smith, *op. cit.*, pp. 221–225 and 263, 1931.

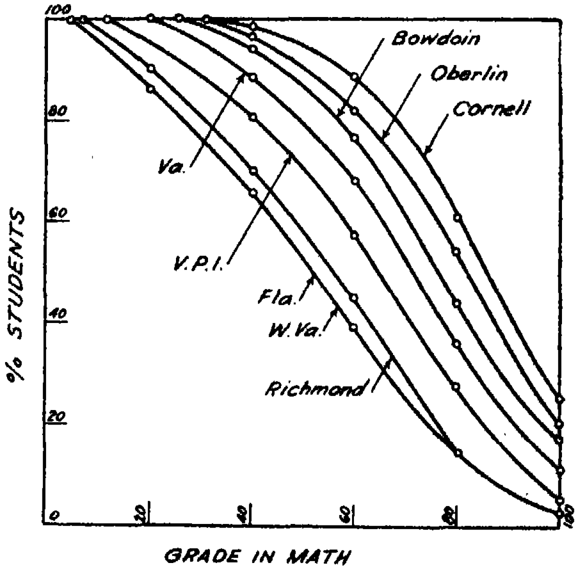
Graph A represents the results of the comparison of grades. Opposite each point is the number of students who made a given grade in mathematics. The ordinate is the average grade in physics made by these students. As is evident from the graph, the averages made in physics seem to be directly proportional to the grade which represents the mathematical preparation of the student. Only in the middle of the range, where the preparation is neither very good nor very bad, is it difficult to predict the success of the student in physics from his mathematical abilities.



GRAPH A

In most institutions physics is considered one of the hardest courses on the campus. The number of failures in physics is usually very high. A great deal of this mortality is undoubtedly due to the very poor preparation of the student in the elements of the mathematics. After all, algebra and trigonometry is a part of the language of elementary physics, and if a student has to spend a great deal of time in unraveling the mysteries of this language he is bound to lose sight of the physical principles involved. It would seem advisable to give suitable tests in mathematics to all who are about to take the beginners' course in physics, and to dissuade from taking the course those students who show very poor preparation.

The results of the mathematics tests gave the opportunity also to compare the preparation of students in various colleges. In graph B, the percentage of the students in a given college is plotted against the mathematics grade these students have attained or exceeded. The three upper curves are those of the endowed colleges.



% OF STUDENTS MAKING GRADE IN MATH.
≥ CORRESPONDING ABSCISSA.
GRAPH B

As it was to be expected, the students of the privately endowed institutions showed a much better preparation than the students of the state institutions. The average grade in the mathematics of the students in Cornell, Bowdoin and Oberlin is about 20 per cent. higher than the average grade of some of the state institutions of the South.

A. A. BLESS

UNIVERSITY OF FLORIDA

BOOKS RECEIVED

Annual of the American Schools of Oriental Research. Vol. XI, 1929–30. Henry J. Cadbury, Editor. Pp. viii + 169. Illustrated. Yale University Press.

GAGE, SIMON H. *The Microscope.* Ultra-violet edition (15th). Pp. viii + 589. 291 figures. Comstock. $4.00.

LEWIS, MELVIN S. and JOHN H. DILLON. *Instruction Sheets for the General Shop: Electricity.* Pp. viii + 91. Illustrated. McGraw-Hill. $.50.

NATIONAL RESEARCH COUNCIL. *Bulletin No. 84: Report of the Committee on Hydrodynamics.* Pp. 634. $4.50. *Bulletin No. 86: Bibliography of Bibliographies on Chemistry and Chemical Technology.* Pp. 150. $1.50. National Academy of Sciences.

OSBORN, CHASE S. *The Earth Upsets: The Story of Earth's Motion.* Pp. 216. Waverly. $3.00.

RICHARDSON, LEON B. *General Chemistry.* Revised edition. Pp. iv + 779. Illustrated. Holt. $3.50.

SMYTHE, WILLIAM R. and WALTER C. MICHELS. *Advanced Electrical Measurements.* Pp. x + 240. 110 figures. Van Nostrand. $3.00.

SCIENCE

VOL. 75 FRIDAY, APRIL 1, 1932 No. 1944

The Present State of the Natural Sciences: PROFESSOR ALFRED STOCK 345

Obituary:
In Memory of Robert Koch; A Monument for Ludwig Boltzmann; Recent Deaths 350

Scientific Events:
Investigations of Locusts; The Field Museum of Natural History; California Academy of Sciences Expedition to Revillagigedo Archipelago; Awards of the Elizabeth Thompson Science Fund; Geophysical Research at Harvard University 351

Scientific Notes and News 353

Discussion:
Nature's Moving Picture: ROBERT VAN V. ANDERSON. *The Chemical Nature of Vitamin C:* DR. C. G. KING and DR. W. A. WAUGH. *Studies in Motor and Mechanical Skills:* DR. ROBERT H. SEASHORE and IVAN N. MCCOLLOM. *How Big is a Cell?* DR. EDGAR ANDERSON 357

Scientific Books:
Bobrovnikoff on Halley's Comet in its Appearance of 1909–1911: DR. CHAS. P. OLIVIER. *Howard on the Insect Menace:* DR. E. P. FELT 359

The American Association for the Advancement of Science:
The Host Institution and Hotel Accommodations for the Syracuse Meeting: DR. CHARLES F. ROOS 361

Scientific Apparatus and Laboratory Methods:
The Estimation of the Hydrogen-ion Concentration of the Tissues in Living Animals: PROFESSOR CARL VOEGTLIN and H. KAHLER. *A Culture Medium for Paramecium:* LAUREN E. ROSENBERG 362

Special Articles:
Size of Infection as an Influence on the Persistence of Adult Trichinae in Rats: DR. O. R. MCCOY. *Succession of Forests as Indicated by Fossil Pollen from a Northern Michigan Bog:* J. E. POTZGER 364

Science News 10

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THE PRESENT STATE OF THE NATURAL SCIENCES[1]

By Professor ALFRED STOCK

DIRECTOR OF THE CHEMICAL INSTITUTE, TECHNISCHE HOCHSCHULE, KARLSRUHE, NON-RESIDENT LECTURER IN CHEMISTRY AT CORNELL UNIVERSITY ON THE GEORGE FISHER BAKER FOUNDATION

IN inaugurating the series of lectures which I am to give at Ithaca during the following months, my first thought is to express to Cornell University and to my colleagues in the department of chemistry, at whose head stands my friend Dennis, my sincere appreciation of their invitation to come to the university for this term under the George Fisher Baker Foundation. It is a great pleasure and honor to me to have the privilege of spending a few months with my American colleagues and personally to become acquainted with the country which to-day plays a leading part in the world in technical and economic achievement, and in which scientific work has a more assured position than in any other land.

This residence in Ithaca will for me be quite a decided change from my usual habits of life and it will afford me a desired opportunity of making a quiet survey of the present state of natural sciences and technology which to-day is nothing but applied and utilized natural science.

Is one justified in saying that we are now confronted with a crisis in the progress of the exact sciences and technology, a statement that is often heard or read in these days at least in our disrupted Europe? Are the exact sciences really unable to penetrate to the depths of human understanding? Will technology become the scourge of mankind, will it lead to the destruction of our economic life, to the embitterment of the soul? Does salvation lie in recourse to metaphysics or to philosophy?

Natural science, in the modern meaning of the term, is but a few hundred years old, although in ancient days there were some very significant technical achievements such as those wonders of the world, the pyramids of the Pharaohs, and a developed technology in ceramics, dyeing and tanning. Astronomy was studied zealously, although chiefly from the astrological side. The alchemy of the middle ages led to the discovery of no small number of chemical facts. But natural science, as we understand it to-day, in which research is carried out not only for practical ends but for its own sake in order to create a well-rounded concept of nature, was developed only on the threshold of modern times. A fresh strong breeze swept through the world and tore down the webs of the Scholastics. Humanism and reformation rendered men's minds receptive to new thoughts and new objectives. The natural sciences devised for their use the instruments without which it was impossible to carry on exact investigation—the clock, the barometer, the thermometer, the telescope, the microscope, the air-pump and many other devices. Men braved the dangers of the sea and gained a knowledge of our earth. Great minds solved the secrets of planetary motion and brought the earth to the modest position that it now occupies in the universe. The alchemical groping among the mysteries of nature was replaced by scientific study, and the invention of printing gave wings to the interchange of thought. Academies of science were founded, and one after another the fields of natural science rose from mere description and empiricism to the discovery and application of mathematically formulated laws. Astronomy and physics were the first to develop. Chemistry and biology followed more slowly. The miracle came to pass that mathematics, apparently the most abstract field of human meditation, proved to be an incomparable aid in the natural sciences and in technology.

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[1] Introductory public lecture.

The past century brought an astonishing development in scientific and technical methods. While in the past progress had been restricted to a few illustrious leaders, there now arose armies of scientific and technical pioneers equipped with elaborate experimental and theoretical aids. With almost the same methods all civilized countries are now carrying forward scientific research, and while at times there flashes forth the brilliant success of an individual, it is probable that the discovery might eventually have been achieved through the methodical, although slower progress of the many, as Professor Desch also pointed out in his recent lecture here. The leader shows the path and the scientific laborers and builders follow in his footsteps, and there quickly springs up a new settlement where a short time ago there was a trackless desert.

This mass production, however, gives rise to many a difficulty. Scientific and technical literature has increased at such a rate as to be terrifying, and it is difficult to keep in touch with all that has been written even within a limited field. It is almost impossible for scientific journals and works of reference to do justice to their subjects. We look forward to the future with anxiety. Things can not be allowed to go on at this pace. Greater restraint is needed, both in the scope of the work and in publishing. This applies also to the excessive number of conventions and congresses, where often the same questions are discussed over and over again.

On the other hand, however, this great activity and research since the beginning of the present centur has led to most remarkable progress in science an technology, as has never before been the case in su a short period. In describing some of the fruits this time, the present speaker can of course only a few examples chosen at random.

Physics, through x-ray optics and the mo electron optics, has greatly extended the ea that embraced only visible light and the ately related field of radiation. The possibil these optical methods (in the widest sense o word) are truly miraculous. They bring us information of what is going on in the most remote sections of the universe, as well as in the interior of the minute chemical atoms; they disclose to us the existence of chemical compounds so short-lived that we can not hope ever to be able to grasp and keep them; they enable us to determine magnitudes that at first seem to have nothing at all to do with optics, as, for example, the measurement of chemical forces.

Electricity has broadened its foundations through the investigation of electrons, which one may regard as the atoms of negative electricity. Every one who enjoys a radio apparatus has some realization of the significance of the discovery and utilization of long-wave electromagnetic rays. Somewhat less comprehensible to lay minds are the equally recent changes in the theoretical concepts of the physicists. Probably the greatest accomplishment in natural science since the days of Copernicus and Newton is the creation of the quantum theory, according to which energy is emitted and received in definite individual portions, or "quanta"-wise, just as the chemical elements occur "atom"-wise. The theory of relativity gave rise among laymen to an unnecessary and excited criticism of their traditional concept of time. Upon the new so-called "wave-mechanics" is based the latest theory of the nature of the atom. The former independence from each other of "mass" and "energy" has now been converted into a mutual relationship. The naïve mechanistic picture of the universe became a victim of these revolutions in our physical concepts, and physics was plunged into a battle of theories and interpretations that still rages. The old uncertainty as to the wave or corpuscular nature of radiant energy was revived. Since it has been shown in America that, even at the high translatory velocity of the earth, the "ether wind" has no effect on the velocity of light, the conflict concerning the nature and even the existence of the universal ether has broken out anew. In fact, one even hears doubts as to whether the law of causality, that rigid connection between cause and effect, extends to and rules the field of the atom's microcosm. Natural science lost one of its most important supports and methods of reasoning when the law of causality was revoked. The present speaker holds with those investigators who assume that the law of causality governs the field of the infinitely minute, and that only our methods of observation and measurement are still too coarse to enable us accurately to trace the causes and the effects of these phenomena. Even the skeptics hold that under all circumstances "statistical causality" continues to be, in the ordinary physical world at any rate, the average result of a statistical plurality.

Modern physics appears to withdraw more and more into the higher sphere of mathematics, and mathematics advances to meet it by devising new mathematical methods.

Nearly all the other branches of natural science have been swept along with the tempestuous developments in physics. At many points we see incisive progress and a breaking away from the older views.

Similar fundamental changes are also apparent in astronomy, the oldest of our sciences. It has greatly expanded its concepts of the universe, employing that much-abused term in its true sense. To-day it looks far beyond our own solar and galactic systems into the most distant realms of universal space. The fixed stars became the object of precise research concerning their chemical composition, magnitude, density, temperature and also their movements. We find many giant stars being assigned densities as low as that of the earth's atmosphere, while in the case of other stars a tremendous mass concentration must be assumed. For example, a dark companion of Sirius is supposed to possess a density of 50,000. Through modern ideas concerning atomic conversion and the transition between matter and energy the balance of astronomic energy has received a wholly new explanation. That slight shift in wave-length, due to the relative motion of light-source and observer which we call the Doppler effect, has revealed to us the relative movements in the universe. By its aid we have recognized centers of motion, and have determined some apparently fantastic velocities up to 12,000 kilometers per second. It can here be mentioned that through researches in the physics of electrons it has recently been possible to solve the problem of the earth's aurora borealis and to show that it is an electronic phenomenon caused by the earth's magnetism.

Chemical research has profited particularly from the progress of modern physics. Spectrum analysis, the quantum and the electron theories, together with "wave mechanics," have enabled the chemist to draw up such a picture of the chemical atom as was never dreamed of a few decades ago when it was considered to be a rigid, unchangeable object. Owing to our modern concepts of the atom with its positively charged nucleus surrounded by electrons, it is possible to explain a multitude of apparently unrelated phenomena, such as the spectra characteristic of the individual elements, "ionization" or the occurrence of electrically charged atoms, the possible "activation" of elements by light, electricity and the like, the chemical similarity of certain elements as expressed in the periodic system, atomic disintegration in the radioactive elements and the remarkable phenomena that accompany it, and the existence of isotopes which behave alike chemically, although having different atomic weights. In the "mass spectrograph" we have a surprisingly simple and accurate mean for determining the atomic weight of isotopes.

Reaction velocities, heretofore one of the least understood fields of chemistry, have been opened up for study by these new ideas. As Haber has expressed it, "We have now gained a first impression of the actual nature of the play staged by chemical processes, where before as Schönbein put it, we have known only what happens before the curtain rises and remains when it has fallen." Evidently here the leading parts are played by the activation of the atoms and the "chain reactions" induced by the energy developed in reactions between individual atoms. Band spectra have enabled us to detect the transitory existence of unusual compounds such as hydroxyl and have thus supplied us with an explanation of many hitherto obscure reactions. Great progress has also been made in our knowledge of the special forces acting on a particle on the surface of a substance, where, contrary to the conditions in its interior, there is no longer that uniform effect due to neighboring surrounding particles. This knowledge has illuminated the once dark and obscure fields of colloid chemistry, adsorption phenomena, contact effects and catalysts.

Nor has classic preparative chemistry been inactive. Among its many remarkable successes during recent years one may mention the preparation of substances of vital importance to the human organism, such as adrenaline from the suprarenal glands, insulin from the pancreatic gland, thyroxine from the thyroid and the vitamins C and D in crystallized form.

Mineralogy has gained a deeper insight of its subject, and to-day directs its attention more to the nature and the arrangement of the smallest structural elements of the crystal lattice than to the external form of the crystal. Our new knowledge concerning radioactivity and the tremendous energy developed by the disintegrating atom has helped geology to secure an essentially different and better founded idea of the nature of vulcanism. The distribution of the chemical elements throughout the various zones of the earth's interior is also much more clearly understood.

Biology is occupied less and less with morphological reasoning and treats biological phenomena as the results of physical and chemical processes. This has made it possible to explain the functioning of the muscles as being relatively simple chemical reactions. The investigation of the hormones, regulators of the most diverse functions of the organism, has made great progress. To mention but a single example: By the aid of the sex hormones, obtained from urine and other substances, it is now possible to direct the development of the individual at will, towards either the female or the male side. One almost shudders in contemplating the fearful power and responsibility thus placed in the hands of the chemist and of the physician.

Enzyme research has shown sound progress. These bodies which in such minute quantities play a wonderful part in the chemical economy of our bodies, in the assimilation of our food and the building up of the body material, have not as yet been isolated in the pure state nor even synthesized. Nevertheless, extensive progress has been made along this path. Methods of purification, concentration and separation have been further perfected by original adsorption methods avoiding chemical changes.

The theory of heredity has opened up a new chapter of great practical significance. Simple regularities, some of which were discovered long ago, have proved to be of fundamental importance for every kind of heredity, in plants, in animals and even in man, as shown, for instance, in the study of hereditary hemophilia. A tremendous amount of observational material about regular and disturbed heredity or mutations, such as can be induced by x-rays, for example, has been investigated. One species of fly, *Drosophila melanogaster*, has attained fame through the service rendered to science by many hundreds of its generations and 20 million of individual specimens. We have come to recognize that the so-called "chromosomes" are the bearers of heredity in the cell, and the study of their mutual effects has revealed the laws of heredity. Agriculture has already begun to profit from these achievements of biological science.

Progress in healing, due to the achievements of the natural sciences, has already brought marked lengthening of our span of life. In civilized countries this period has almost doubled during recent years. Whether this prolongation is an unmixed blessing for the inhabitants of this globe—under modern economic conditions at least—is an open question. Another wonderful biological discovery is that of the so-called "mitogenetic" rays, a radiation of an ultraviolet nature that arises during biological processes, as, for instance, the growth of onion roots or the development of tadpoles. Although these rays are as yet not wholly understood, they are expected to solve biological problems, such as those of cell division. Perhaps this discovery constitutes the first step into a field, so far scarcely considered, that may prove of special importance for human life: the influence of electron processes, the activation of molecules, the effect of radiations and electrical charges on the living organism.

Applied science—technology—at first followed pure science with halting steps, but to-day it frequently points out the way to new and valuable lines of research. When one recalls that the steam engine was invented hardly more than one hundred years ago, the railroad began its service, and cotton came into use as a textile fiber, we seem to be dreaming when we think of the modern achievements of technical science, such as the vast railroad net covering the face of the globe, the miracles of engineering, the progress in electricity, aviation and wireless telegraphy, and the multiplied yield of the soil. Science is tireless in its efforts to advance technology still further, to furnish it with the most suitable material for every purpose, to make it independent of natural raw materials, to open up new sources of power and to simplify and cheapen its work. To-day industry clearly understands the great value of scientific research, and it not only has given valuable aid to university investigation but has also established excellently equipped research laboratories of its own.

The same efforts towards unification that characterize science and technology are wiping out the boundaries between the different natural sciences. This fact strongly characterizes the more recent developments. Astronomy, physics, chemistry, mineralogy, geology and biology are all merging more and more into one science of nature which everywhere is working with similar experimental and theoretical mathematical means. Physics and chemistry have already become more or less identical.

Even "exact" science and "metaphysical" or mental science bear witness to this modern tendency toward amalgamation. Very significant of this fact was a recent meeting at Prague of physicists, philosophers and mathematicians for mutual interchange of ideas and for general discussions. This being a first attempt, it was not easy to find a common basis of understanding and agreement. But do the different philosophical schools understand one another? It is undeniable that philosophy has already been strongly influenced by modern research in natural science. This influence increases the more, the further the individual branches of natural science progress toward an all-embracing theory of nature. To-day wide circles of philosophers no longer consider their objective as "systems" and philosophical "images of the universe," but a gradual advance in knowledge confirmed by the natural sciences. Thus philosophy becomes the forerunner and the guide for natural science. Driesch has written: "The philosopher reflects upon what is possible in those fields not yet wholly understood, and that means almost all of them, and submits his results to the investigator for decision. In exchange he continually receives from the investigator new material needing reflection and discussion." According to Russell, philosophy, as well as every other line of research, strives first after knowledge; as soon as final knowledge has been secured in any field, then that is no longer called "philosophy" but becomes an individual science. Formerly the investigation of heavenly phenomena, now called astronomy, was treated as a part of philosophy. More recently the study of the human soul was separated from philosophy and became psychology. "In philosophy," writes Carnap, "we experience the drama, depressing to scientific minds, of seeing a plurality of incompatible philosophic systems being erected one after the other and side by side." Von Mises says: "In aim, subject and method there is only *one* science, namely, the reconstruction of the world through concepts. The division of this science into two parts, into 'mental' and 'natural' sciences is only of a practical and transitory significance, it is not systematic and final." According to Spengler, "the unconscious longing of every true science is directed towards understanding, penetrating and embracing the universe as a whole." Driesch says: "No man is possessed of the pure *will to know,* independent of any practical considerations, to such a degree as the student of nature." Here we have philosophers and mathematicians testifying how far the natural and mental sciences have progressed toward mutual understanding.

Technology also seeks to get into touch with the mental sciences, having wearied of "mechanism," "rationalism," "materialism," or whatever other, once highly esteemed but now much abused, names may be applied to the pursuit of the purely technical. It examines with a critical eye its position within the totality of life and tries to find its place in human culture and economics. An American industrial leader coined the term "human engineering": Technology has to consider the human dignity of labor and how to smooth out the conflict between capital and labor. In the future, successful industrial work will depend more on the handling of men than on the improvement of machines. Plank foresees the development of a "meta-technology" as "the totality of technical economic thought and work, surpassing the limits of that which is based merely on reason and which is expressible in formulas and symbols."

This picture of the present state of the natural sciences, which, on account of the magnitude of the subject and the short time at the speaker's disposal, can be no more than an incomplete sketch, will show the overwhelming life force animating pure and applied natural sciences. There is no hint of weakening, of stopping or of that resignation expressed in Du Bois-Reymond's "Ignorabimus." All along the line there is a strenuous, often a revolutionary struggle for progress, a tendency to clear up contradictions, to unify our ideas regarding nature and the universe, a complete belief in the "possibility of unveiling the truth" and in the existence of "an eternal order that rules the world" (Planck).

Much has been done in the past, more remains to be accomplished. The student of nature should still be as modest as Newton, who said of himself that he seemed to be like a child playing with pebbles on the shore while before him stretches the infinite ocean of the unknown. Although no field of natural science is lacking in vastly important unsolved problems, their outlines are recognizable; and no one knows what lies hidden in the obscurity of the future. If Archimedes escapes death by the rough hand of the soldier, the natural sciences may long continue their triumphant march.

In Ostwald's pyramid of the sciences, sociology stands on the apex. It may be counted as one of the natural sciences, but its subject is the most complicated and incomputable of all natural products. The highest problem for the scientific mind to solve will be—how to free mankind from political, economic and social limitations and how to give it a purer and broader-minded understanding of humanity and sympathetic mutual coöperation.

OBITUARY

IN MEMORY OF ROBERT KOCH

President Hoover called on the nation on March 21 to join in honoring the memory of Dr. Robert Koch on the occasion of the fiftieth anniversary of his discovery of the bacillus of tuberculosis. The proclamation read:

> Fifty years ago, on March 24, 1882, Robert Koch, a German doctor, startled the medical circles of Europe by announcing he had discovered the germ that causes tuberculosis.
>
> The steps he took to prove his opinion, and the clarity with which he explained those steps, made his report not only a classic in medical literature but established a technique in medical research that ever since has been a boon to civilization in its fight against disease.
>
> Next Thursday the fiftieth anniversary of Robert Koch's discovery of the tubercle bacillus will be commemorated throughout the world. Unstinted honor will be paid to the memory of the famous man who, almost single handed, directed the feet of nations toward the path of victory in the relentless, though silent, war against the destructive forces of nature.
>
> In the United States the benefits of Koch's discovery loom large in light of the fact that the death rate from tuberculosis is now but one fourth what it was in 1882, and the search for a specific cure, as yet undiscovered, goes steadily forward along the lines he mapped out.
>
> Because of his priceless contributions to human welfare it is fitting that we, as a nation, do him honor, and that each community acknowledge its debt to Robert Koch by commemorating in an appropriate manner the occasion of the fiftieth anniversary of his discovery of the tubercle bacillus.

A MONUMENT FOR LUDWIG BOLTZMANN

Some time ago I received a letter from the physicists of Vienna, an abstract of which I am translating herewith:

> The Mayor of Vienna has agreed to dedicate a grave of honor to Boltzmann and has agreed to bear the cost of caring for it. Indeed the remains of Boltzmann have already been buried in this tomb, which is situated in the most beautiful and most prominent place in the new part of the municipal central cemetery. While the city bears all the costs—as an exception, even the costs of transfer—it is thought that a monument commensurate with the importance of Boltzmann should be erected.
>
> You will understand without our going into details, that with the present situation in Austria only a small part of the sum necessary for the monument can be collected there. The costs of a monument amount, even with great economy, to about 8,000 to 10,000 Austrian shillings ($1,150 to $1,430). We know that the memory of Boltzmann is still alive in America, as he had been active at the University of California and as some of the influential physicists in American universities and perhaps also in American industry, are students of Boltzmann, directly or indirectly.
>
> Our request is now, whether you would use your influence with the scientists mentioned above and possibly with others, who appreciate Boltzmann's work, to help in the realization of our plan.
>
> Are there in America large associations (The American Physical Society or The American Mathematical Society, for example) who would be inclined to make the erection of the monument possible through larger contributions?
>
> May we ask you, if this action is successful, to act as receiver of gifts and keep them until the present exchange difficulties in Austria are over—or the bills for the monument come due? If you wish, this letter may be made public.

This letter is signed for the Chemical-Physical Society by Professor Arthur Haas, and for the heads of the Physical Institute of the Universität of Vienna, and of the Radium Institute of the Academy of Sciences in Vienna by Professor Gustav Jäger, Stefan Meyer, Felix Ehrenhaft, Egon Schweidler and Hans Thirring.

The treasurer of the Johns Hopkins University has kindly consented to accept contributions for the erection of the Boltzmann Monument: Checks may be made payable either to him or to me. Of course, I expect under present conditions only small contributions from individuals, and might perhaps suggest $2.00 or $3.00 as a reasonable amount.

K. F. Herzfeld

The Johns Hopkins University,
Homewood, Baltimore, Md.

RECENT DEATHS

Dr. Clifford Richardson, consulting chemical engineer, from 1900 to 1910 proprietor of the New York Testing Laboratory and earlier superintendent of testing for the Barber Asphalt Paving Company, died in Paris on February 28, at the age of seventy-five years.

Charles Livingston Bull, formerly taxidermist at the U. S. National Museum, author and naturalist, died on March 22. He was fifty-seven years old.

Professor D. H. Marshal, emeritus professor of mathematics and physics, Queen's University, died at Kingston, Ontario, on March 14, at the age of eighty-four years. Professor Marshal was formerly professor of mathematics and physics at the Imperial College of Engineering in Tokyo.

Dr. Alexander Dougall Blackader, emeritus professor of pharmacology, therapeutics and pediatrics, McGill University, died on March 14. He was eighty-six years old.

DR. E. H. GRIFFITHS, physicist and formerly principal and professor of experimental philosophy at the University College of South Wales, died at Cambridge on March 3, at the age of eighty years.

THE death is announced on February 29 at the age of eighty-one years of Dr. George Claridge Druce, curator of the Fielding Herbarium of the University of Oxford.

DR. ADAM SCHWAPPACH, formerly director of the Eberswalde Forest Experiment Station at Eberswalde, Germany, died on February 9, at the age of eighty-one years.

PROFESSOR A. OPPERMANN, director of the Danish Forest Experiment Station at Springforbi, Denmark, died on November 15, at the age of seventy-two years.

SCIENTIFIC EVENTS

INVESTIGATIONS OF LOCUSTS

THE French Committee for Locust Research, consisting of entomologists and chiefs of plant protection services in all the French African Colonies, has agreed to recognize the Imperial Institute of Entomology in London, according to the London *Times*, as the international center for the collection of data on the appearance and movements of locust swarms. This decision follows on the locust conference which was held recently in Rome to discuss methods of international cooperation in locust research, which was attended by British, French and Italian representatives. The Italian delegates agreed to recognize the Imperial Institute of Entomology as the international center for research, but the French delegates were unable to commit themselves without referring the matter to their locust research committee, which has now endorsed the decision of the Rome meeting.

As a result of this resolution, the Imperial Institute of Entomology will in future receive automatically all the information on locusts available in the French African possessions. This is being regularly transmitted by local authorities to the Algiers Regional Station. French entomologists will also cooperate in the locust investigations in the Timbuctoo area, which British entomologists from Nigeria hope to undertake. This area is strongly suspected to be one of the original sources of the present locust outbreak in Africa.

A general scheme of locust research, which aims at discovering the locusts' permanent breeding areas, is now in operation and is directed from the Imperial Institute of Entomology. This is financed partly by the British African Colonies and partly by the Empire Marketing Board, but, owing to the need for economy, the funds available have recently been reduced by half. Two locust research officers have been appointed. One is now in Uganda advising the government on problems of locust control, and particularly on the failure of poison bait. The other is studying the conditions under which locusts are breeding in the Sudan. Information on the movements of locusts is now being received from 16 empire and 25 foreign countries by the Imperial Institute of Entomology and analyzed there in order to trace the origin of locust swarms, the routes of their invasions, and the probable causes of the outbreaks.

THE FIELD MUSEUM OF NATURAL HISTORY

THE annual report has appeared of Mr. Stephen C. Sims, director of the Field Museum of Natural History, Chicago. He states that despite the economic depression, which naturally has had serious effect upon the museum's finances as upon those of practically all similar institutions, so far as the public is concerned, the museum's services have been maintained with practically no curtailment.

All forms of educational work for both children and adults, such as the public lectures on science and travel, guide-lecture tours, etc., have been carried on as usual. The activities of the unit of the museum organization known as the James Nelson and Anna Louise Raymond Foundation, consisting of entertainments for children, extension lectures in the schools, and other forms of direct contact work between museum instructors and more than 300,000 children, have been increased. Likewise the circulation of some 1,300 traveling exhibits in about 400 schools has been continued without interruption.

Work on the installation of new exhibits and the reinstallation of older exhibits proceeded as usual. The scope of expeditions, however, was reduced and it was in this branch of activity that a large part of the necessary economies were effected. However there were sixteen expeditions in operation, both in America and foreign countries, though most of these were on a smaller scale than those of previous years.

Details of contributions of both funds and exhibition material and lists of the institution's 5,341 members are contained in the report.

The number of visitors during 1931 was 1,515,540, exceeding all previous records. Adding the numbers of children reached by activities conducted outside the museum by the Raymond Foundation and the Harris Extension, the total number of persons directly reached by the museum's educational influence was more than 2,240,000. Use of the museum library by students and by the public in general increased; more than 93,000 natural history books and pamphlets are now available on its shelves. A new and greatly improved cafeteria was built and opened to the public in the museum building. Reports are included of the Field Museum-Oxford University Joint Expedition to Mesopotamia which is excavating on the site of the City of Kish; the Suydam Cutting zoological expedition to Sikkim, India; a zoological expedition to Indo-China conducted for the museum by Mr. George F. Ryan and Mr. George G. Carey, Jr.; a zoological expedition to central Africa conducted by Captain Harold A. White and Major John Coats; the Marshall Field Zoological Expedition to China; the Third Marshall Field Archeological Expedition to British Honduras excavating ancient Maya sites, and the Field Museum Archeological Expedition to the Southwest excavating prehistoric Indian ruins in Colorado.

CALIFORNIA ACADEMY OF SCIENCES EXPEDITION TO REVILLAGIGEDO ARCHIPELAGO

THE director of the museum and of the Steinhart Aquarium of the California Academy of Sciences, Dr. Barton Warren Evermann, writes that, on the evening of March 10, the *Zaca* passed out through the Golden Gate to enter on a protracted cruise among the Revillagigedos and other islands off the Pacific Coast of Mexico, Central America and Ecuador, in the interest of the California Academy of Sciences. The *Zaca* is the private yacht of Mr. Templeton Crocker, of San Francisco, who is deeply interested in the scientific and educational activities of the academy of whose board of trustees his father, the late Colonel Fred Crocker, was president for many years. The expedition will be known as the Templeton Crocker 1932 Expedition of the California Academy of Sciences. Among those on board besides Mr. Crocker are the following: Captain Garland Rotch, commanding officer; Dr. Albert E. Larsen, ship's doctor; Harry S. Swarth, ornithologist and mammalogist, naturalist-in-charge; John Thomas Howell, assistant curator of the academy herbarium, botanist; H. Walton Clark, assistant curator of the department of fishes, aquatic zoologist and ichthyologist; Robert J. Lanier, assistant superintendent of the Steinhart Aquarium of the California Academy of Sciences, fishery expert; Toshio Asaeda, artist and official photographer, and Maurice Sheppard Willows, Mr. Crocker's secretary, entomologist.

Mr. Swarth recently completed a technical report (Occasional Paper No. 18, California Academy of Sciences) on the land birds of the Galapagos Islands, based upon a critical study of the large collection of 8,691 specimens of birds collected on the 1905–1906 expedition of the California Academy of Sciences to the Galapagos Islands, and the material from those islands in the British Museum and in that at Tring. On the present expedition he will pay special attention to the habits, life histories and ecological relations of the various species. Dr. Larsen will pay special attention to the intestinal and other parasites of the elephant seal and other mammals. Messrs. Clark and Lanier will collect the fishes and other aquatic species. They hope to bring back several large tanks of live tropical fishes for the Steinhart Aquarium, and large series of specimens preserved in alcohol of the fishes, mollusks and crustaceans found in the various regions visited. They will also make complete collections of all obtainable species of marine algae which will be turned over to Drs. Setchell and Gardner, of the University of California, for study and report.

Mr. Howell will study the flora of the various islands and goes prepared to make large and valuable additions to the academy's herbarium already rich in materials from these islands. Mr. Willows will pay special attention to the Lepidoptera, Hemiptera and Coleoptera, groups not well represented in museums in collections from any of these islands. Mr. Asaeda, who was artist and photographer of the recent expedition which Mr. Zane Grey made to tropical islands in the Pacific, is not only a high class artist but also an expert color photographer. He has had much experience in painting fishes and other aquatic animals in life colors.

Mr. Crocker and Captain Rotch also are skilled in moving picture photography. On a short visit to Guadalupe Island last November for the academy, they obtained very interesting reels depicting life of the wonderful elephant seal herd found there.

The present expedition is made possible by Mr. Templeton Crocker because of his interest in the California Academy of Sciences and his desire to assist scientific research through the academy's research departments.

It goes equipped for collecting in all fields of vertebrate zoology and in botany, and will cover the fauna and flora of both land and sea as fully as possible. Specially constructed electrically-lighted traps that can be let down to a depth of one thousand feet will be used for capturing deep sea fishes that, it is hoped, may be attracted by the light. Special dredges that may be dragged on the bottom or at intermediate depths, have been provided. Provision has been made also for regulating the water in the live tanks so that fishes and other species intended for the aquarium can be brought back alive.

This is the second expedition Mr. Crocker has financed for the academy, the first being that to Guadalupe Island last November. A third expedition chiefly in the interest of the academy was that of Captain G. Allan Hancock's cruiser *Valero III*, to the Galapagos Islands last winter (December to February), with Mr. Alvin Seale and Dr. Leo George Hertlein on board representing the academy.

AWARDS OF THE ELIZABETH THOMPSON SCIENCE FUND

PREVIOUS awards from the Elizabeth Thompson Science Fund have been reported in SCIENCE, November 25, 1931, and earlier. Since the last report the following awards have been made:

At the Meeting of February 25, 1932

No. 305 to E. D. Merrill, New York Botanical Garden, $50 to obtain translations of Japanese literature published in Japanese characters, and with Japanese titles, necessary for the preparation of an exhaustive bibliography covering the botanical literature pertaining to Eastern Asia.

No. 306 to W. J. Hamilton, Jr., Zoological Laboratory, Cornell University, $100 toward expenses in making observations on long-tailed shrews of the genus Sorex.

No. 307 to K. K. Landes, University of Kansas, $200 for aid in the study of pegmatite mineral deposits in Colorado and New Mexico.

No. 308 to Carroll Lane Fenton, West Liberty, Iowa, $300 for aid in undertaking the study of a certain group of fossils already described long since but needing a careful re-study to fit them into the whole system of corals.

No. 309 to G. H. Burrows, University of Vermont, $100 for aid in purchasing chemicals and minor pieces of apparatus to be used in the determination of equilibria among reactions of organic chemistry.

The Trustees of the Elizabeth Thompson Science Fund meet ordinarily during the last ten days of the months of February, May and November. Applications for grants should be sent well in advance of the meeting to the secretary of the fund, Dr. Edwin B. Wilson, 55 Van Dyke St., Boston, Massachusetts.

GEOPHYSICAL RESEARCH AT HARVARD UNIVERSITY

AN account is given in the *Harvard Alumni Bulletin* of a project for geophysical research undertaken by the university which will concentrate at the start on data of basic value in seismology, in particular the study of the properties of certain rocks and rock minerals under very high pressures and at high temperatures. The investigation will continue for five years.

The plan is made possible by a gift of $50,000 from the Rockefeller Foundation, $10,000 each year, contingent on the raising of an equal amount from friends of the Harvard departments concerned. The necessary amount for the first year has been obtained from the latter source, and a substantial amount pledged for the other four years.

The work will be administered by the division of geology, under the guidance of an inter-departmental committee consisting of Professor R. A. Daly, of the division of geology, chairman, and Professors P. W. Bridgman, of the physics department, L. C. Graton, of the Engineering School, Harlow Shapley, of the Astronomical Observatory, and D. H. McLaughlin, of the division of geology.

In acknowledging the gift, the committee said: "The opportunity to undertake work in this important field, which is made possible for a period of five years by the generosity of a small group of loyal friends of the university and by the encouraging and stimulating assistance of the Rockefeller Foundation, is a gift of very real value to Harvard."

To accomplish the difficult task of combining high pressures with high temperatures, apparatus is now being designed by Professor Bridgman, under whose direction the research on the elastic properties of rocks and the effects of high temperature and pressure will be carried out. Field measurements of the velocity of seismic waves in rocks of different types are already under way by means of artificially-produced earthquakes of small scale, in carefully selected localities where geologic details are accurately known.

Research will later be undertaken for an improvement of the records of distant earthquakes and in the methods of interpretation thereof.

SCIENTIFIC NOTES AND NEWS

THE fiftieth anniversary of the announcement by Robert Koch before the Berlin Physiological Society on March 24, 1882, of the cultivation of the tubercle bacillus, was celebrated on March 24 at the Rockefeller Institute for Medical Research in New York. The speakers were Dr. Theobald Smith, Dr. Karl Landsteiner and Dr. Simon Flexner.

DR. R. A. DALY, of Harvard University, has been awarded the Hayden Memorial Gold Medal for 1932 of the Academy of Natural Sciences of Philadelphia in recognition of his studies of igneous rocks, the constitution of the earth and other geological researches. The presentation will be made at a meeting of the academy this month.

THE John Scott award for achievement in science, given by the City of Philadelphia, was presented on March 10 to Marchese Guglielmo Marconi, inventor of wireless telegraphy, by Ambassador John W. Garrett.

THE honorary degree of LL.D. will be conferred on May 11 by the University of Manchester on Lord Rutherford and on Sir James Jeans.

PROFESSOR RALPH S. HOSMER, head of the Department of Forestry in the New York State College of Agriculture, has been elected a fellow of the Society of American Foresters. Professor Hosmer is one of thirteen men chosen for this honor since the society was founded in 1900.

THE Sultan of Morocco has conferred the title of Officer of the Order of Ouissam Alouite upon Professor Robert W. Hodgson, of the division of subtropical horticulture in the College of Agriculture of the University of California. The honor was conferred on Professor Hodgson at the request of the French authorities in recognition of his studies of citrus growing in the protectorate.

SIR GEORGE BUCKSTON BROWNE, donor of Down House and of the Royal College of Surgeons Research Farm, Kent, has been elected a member of the Athenaeum Club for distinguished service.

LORD DAWSON of Penn, president of the Royal College of Physicians, and Sir Henry S. Wellcome, founder of the Wellcome Research Institution, have been elected honorary fellows of the Royal College of Surgeons.

THE Cameron Prize for additions to practical therapeutics has been awarded to Dr. Edward Mellanby, professor of pharmacology in the University of Sheffield.

THE progress medal of the Royal Photographic Society of Great Britain has been awarded to Dr. Lüppo-Cramer, head of the photochemical laboratory of the Gelatin Works at Schweinfurt, Germany.

Industrial and Engineering Chemistry reports that at a meeting of the council of the Muslim Association for the Advancement of Science held at Aligarh, India, on December 2, 1931, Mr. H. W. Blood Ryan, controlling editor of *The Chemical News*, London, was appointed vice-president and honorary foreign secretary for Europe in recognition of his work for the advancement of international science. Dr. Ryan was also nominated to a newly established foundation research chair in physical chemistry.

DR. J. BEN ROBINSON, dean of Baltimore College of Dental Surgery, University of Maryland, has been elected president of the American Association of Dental Schools.

IT is reported in *Nature* that at the annual general meeting of the Geological Society of London, held on February 19, the following officers were elected: *President*, Sir Thomas Holland; *Vice-presidents*, Professor E. J. Garwood, Mr. J. F. N. Green, Mr. W. Campbell Smith, Dr. H. H. Thomas, and Professor W. W. Watts; *Secretaries*, Professor W. T. Gordon and Professor P. G. H. Boswell; *Foreign Secretary*, Sir Arthur Smith Woodward; *Treasurer*, Mr. F. N. Ashcroft.

DR. JOHN ARCHIBALD VENN, Gilbey lecturer in agriculture in the University of Cambridge and junior fellow and bursar of Queens College, the son of the late president of Gonville and Caius College, has been elected president of the Queens College, in place of the late Reverend T. C. Fitzpatrick.

THE chair of medicine at the College of France, vacated by the retirement of Professor D'Arsonval, has been filled by the appointment of Professor Nicolle, of Tunis.

DR. J. E. DUERDEN, after serving for twenty-seven years, has retired from the professorship of zoology at Rhodes University College, Grahamstown, South Africa, and also from the directorship of Wool Research for the Union. His future address will be: Wool Research Association, Torridon, Headingly, Leeds, England.

PROFESSOR C. J. CURTMAN, of the College of the City of New York, and Professor Ingo W. D. Hackh, of the College of Physicians and Surgeons of San Francisco, have been appointed members of the editorial board of *The Chemical News*, London.

THE object of the expedition to Peru of Mr. Carl O. Erlanson and Dr. Howard MacMillan was incorrectly stated in a recent issue of SCIENCE. Their object is to study the wild relatives of the cultivated potato in Peru and Chile and to bring back plant material for the possible breeding of disease-resistant strains of the cultivated potato. The expedition is a continuation of the work started the year before last in Mexico and is part of the Department of Agriculture's general breeding program for potato improvement.

DR. WILLIAM B. CASTLE, assistant professor of medicine at the Harvard Medical School, has returned to Boston from Porto Rico where he carried on studies on anemia.

ON March 11, Dr. Joseph Colt Bloodgood, clinical professor of surgery at the Johns Hopkins University School of Medicine, gave a clinic on cancer of the breast at the Duke Hospital, Durham, N. C. On the same date Dr. George R. Minot, professor of medicine at the Harvard Medical School, and director of the Thorndike Memorial Laboratory at Boston City Hospital, lectured before the Durham-Orange County Medical Society, at the Duke Hospital, on "The Treatment of Anemia." He also gave a clinic at the hospital the following morning.

DR. A. C. IVY, professor of physiology and pharmacology, Northwestern University Medical School, Chicago, will deliver the annual Gorgas Medical Society Lecture at the School of Medicine, University of Alabama, on May 7. Dr. Ivy's subject will be "The Physiological Aspects of the Etiology, Symptoms and Treatment of Peptic Ulcer."

DR. DAVID I. MACHT, clinical lecturer at the Johns Hopkins University, was the speaker at a meeting of the Johns Hopkins Chapter of Sigma Xi, held at the School of Hygiene and Public Health on March 21. His subject was "Contributions to Phytopharmacology, or the Applications of Plant Physiology to Medical and Chemical Problems."

THE Sixth Annual Priestley Lectures of the Pennsylvania State College will be given from April 13 to 19 by Dr. Victor K. LaMer, associate professor of chemistry, Columbia University. The subject of the lectures will be "The Physical Chemistry of Solutions."

DR. W. V. BINGHAM on March 18 delivered an Aldred Lecture at the Massachusetts Institute of Technology, the subject being "Adventures in Industrial Psychology."

THE Romanes Lecture for 1932 at the University of Oxford will be delivered by Lord Moynihan on June 1. His subject will be "The Advance of Medicine."

SIR OLIVER LODGE on March 17 delivered the Founders Oration at the University of London. He spoke on "Changes in the Scientific Outlook."

THE executive committee of the American Association for the Advancement of Science will hold its regular spring meeting at the Cosmos Club in Washington on Sunday, April 24, with a morning and an afternoon session. Business to come before the committee at this meeting should be sent to the permanent secretary, Dr. Charles F. Roos, Smithsonian Institution Building, Washington, D. C.

THE fifth International Congress of Entomology will be held in Paris from July 16 to 22, under the presidency of Dr. Paul Marchal, member of the institute and professor at the National Institute of Agronomy.

THE twelfth Congress of Industrial Chemistry will be held at Prague, from September 25 to October 1, under the auspices of the French Society of Chemical Industry and the Chemical Societies of Czechoslovakia. The organization committee in Prague cordially invites all American chemists and technologists who are interested to attend, to present papers and to take part in the functions and discussions. Those desirous of attending may write direct to the Organization Committee, Stepánská 37, Prague II, C. S. R., or to Dr. Jerome Alexander, Secretary American Section, Society of Chemical Industry, 50 East 41st Street, New York City.

THE second Congress of the International Society of Orthopaedic Surgery will be held in London at the Royal Society of Medicine on July 19, 20, 21 and 22, 1933, under the presidency of Professor Nové-Josserand of Lyons.

IN addition to a full year's work in undergraduate courses in inorganic, organic, analytical and physical chemistry, during the eight weeks beginning on June 27, the University of Pittsburgh will offer graduate courses in chemical microscopy, under Dr. E. V. Hjort; quantitative organic microanalysis, under Dr. W. Baldwin; biochemistry and physiological chemistry, under Dr. C. G. King, and modern chemical theories, under Dr. A. L. Robinson. These graduate courses will also begin on June 27, and may be arranged according to the needs of the individual student.

THE department of geography of the College of the City of Detroit is announcing two study field courses for this summer. A course in the geography of Europe, under the direction of Dr. S. Van Valkenburg, is planned for eight weeks beginning on June 18. France, Northern Italy, Switzerland, Belgium and Holland will be visited. The second party, conducted by Dr. Bert Hudgins, will travel by bus, the itinerary including Niagara Falls, New York, Atlantic City, the Shenandoah Valley and the Bluegrass region of Kentucky.

DR. WM. D. REEVE, professor of mathematics at Teachers College, Columbia University, will offer a series of special lectures at the University of Nebraska from June 13 to 24 on methods of teaching mathematics in junior and senior high schools. Dr. Reeve will continue the series of special lectures which was begun last summer by Professor Charles Swain Thomas, of Harvard University, and Dr. W. L. Carr, of Teachers College, Columbia University.

DR. G. W. CONREY, of the Ohio Agricultural Experiment Station and the Ohio State University, gave a lecture on February 15 before the department of geology and geography of Oberlin College on "The Geology of Soils." On March 16 Dr. Walter H.

Bucher, of the University of Cincinnati, spoke to a similar audience on the "Life of Cincinnatian Seas." The third and last lecture in the series will be given on April 25, by Dr. Frank Van Horn, of the Case School of Applied Science, Cleveland, on "The Diamond and Gold Mines of South Africa."

A SERIES of three lectures on bio-electric processes will be delivered at the University of Texas, April 12, 13 and 14, by Dr. E. J. Lund, professor of zoology at that institution. Dr. Lund was named graduate research lecturer for 1931–32. The titles of the lectures are "A New Mechanism for Cell Correlation in Living Organisms," "Control of Current Life Processes by Electric Currents" and "How Does the Living Cell Generate Electrical Energy?"

THE following resolution was recently approved at a meeting of the Board of Overseers of Harvard University: "The faculty of the Bussey Institution having ceased to exist, and there being a desire to retain the degree of master in forestry, voted that the Faculty of Arts and Sciences shall hereafter administer that degree."

TWENTY Columbia professors have became staff members of the New York Post-Graduate Medical School by appointment of the university's trustees. The school has been affiliated with Columbia since last July 1. Those appointed were: Dr. Cameron Bailey, T. Drysdale Buchanan, Dr. John A. Killian, Dr. George Miller MacKee, Dr. Walter T. Dannreuther, Dr. Duncan MacPherson, Dr. Herman O. Mosenthal, Dr. Michael Osnato, Dr. Byron Stookey, Dr. Martin Cohen, Dr. Harold S. Vaughan, Dr. Fred H. Albee, Dr. Warren C. McFarland, Dr. Ward J. MacNeal, Dr. Roger H. Dennett, Dr. Philip R. Lehrman, Dr. William H. Meyer, Dr. John F. Erdmann, Dr. John J. Moorhead, Dr. Joseph F. McCarthy. The school's monthly enrolments since the affiliation with Columbia have totaled 980, as compared with 794 for the nine months preceding the union. Dr. Edward H. Hume is director of the school, and the administrative board, composed of staff members and a group of Columbia officials, now includes Dr. Alan R. Anderson as secretary.

SCIENCE SERVICE reports that the U. S. submarine S-48, carrying a staff of scientists and apparatus designed for measuring the force of gravity under water, arrived at Miami on March 23, ending a cruise among the West Indies begun on February 7. The leaders of the expedition are Dr. Richard M. Field, of Princeton University, and Dr. F. A. Vening Meinesz, of the University of Utrecht and the Netherlands Geodetic Commission. Dr. Meinesz is the inventor of the gravity-measuring pendulum apparatus. "This is the first time we were able to obtain real data which has a bearing on earthquakes," Dr. Field stated. "Dr. Meinesz has developed a specially constructed pendulum to determine gravitation. Once this was determined we were able to speculate as to the character of rock formations, columns of rocks of different kinds having certain gravity. With this certain gravity we can tell what kind of rock should be there and knowing that determine the topography of the sea floor and how it was produced. It will be three months before the field data and preliminary calculations which we have made are computed. From the isostatic reduction of these we can find if certain blocks are in or out of balance and whether they should go up or down." With Dr. Meinesz' apparatus in the submarine, 55 dives were made to approximately 70 feet under the surface. Soundings were made every fifteen minutes coincidentally with the gravitation tests. Four dives were made between Nassau and Miami. Fifty-one dives were made in 33 days from February 7. The cruise made a total of 4,000 miles in three loops. The first was southward of Jamaica and around the west end of Cuba. The second around the Caicos bank through Caicos and Turks Island passage. The third was from Guantanamo through the Bahamas to Nassau and Miami.

THE Universities of Virginia and Michigan are cooperating in an investigation of the chemistry and pharmacology of morphine, with the object of removing the dangerous characteristics of this drug. The research is being carried out under the auspices of the National Research Council through its Drug Addiction Committee. It is now announced that the Rockefeller Foundation will finance the work for three more years. With the funds originally available the committee mapped out a three-year program. At the half-way mark in this program Dr. Charles W. Edmunds and Dr. Nathan B. Eddy, in immediate charge of the work, report satisfactory progress. Nearly one hundred new morphine derivatives and closely related substances have been prepared at the University of Virginia and examined at the University of Michigan. Reports on the chemistry of these substances have appeared from time to time in *The American Journal of Chemistry*, and *The Journal of Pharmacology* will publish shortly two papers on some of the pharmacological results. On the basis of these results the Rockefeller Foundation has taken over the financial responsibility for the work and has granted to the National Research Council funds for its continuance for an additional three-year period. The sum granted not only will provide for the extension of the work to January 1, 1936, but will allow some increase in the yearly budget, so that the investigation can be carried out more vigorously.

DISCUSSION

NATURE'S MOVING PICTURE

It is a fair question whether there is not something in our attitude toward photographic illustrations that makes us prone to let down exact standards. In scientific literature it is comparatively rare to find photographic reproductions of natural scenes accompanied by the full titles that they deserve. There is no system, and the standards of precision are lax. Even more is this true of general literature, but it is for science to set an example. An appeal is needed for more care and exactness in the titling of such photographs, and particularly for the definite assignment of each scene to its position in space and time.

One is apt to think of scenes as static and to lose sight of the fact that a photograph is a momentary and irreplaceable glimpse of nature's moving picture. If properly documented the photograph becomes a potentially important record of a stage in many dynamic processes. It depicts far more than the special point that the author desires illustrated, and the reader may be more interested in some other feature. To yield the full value with which every true scientist would wish to endow his illustration it must be titled with as great care as devoted to an important specimen. A first essential is that the reader be told where and when the scene transpired.

The publication of photographs in scientific papers is something of a luxury and only selected ones can be reproduced. Hence the more obligation to other sciences and to future generations to conserve all elements of value in the record. Authors and editors might well adopt as an axiom that a photograph is not worth publishing if it is not worth care in giving it a title of general and permanent utility. The statement of particulars as to the locality and time require no more space than the irrelevant or "show-window" verbiage in frequent use.

If one wished to indulge in muck-raking in scientific swamps, examples of offenses and offenders could be brought to light on every hand. The present writer might be the first conducted to the bar of justice. But to avoid personalities the following imaginary, though not exaggerated, example may be cited in illustration: "View looking along a street showing how the people live by making shoes." Here we have the useful information that it is a view and not a smell, that we are looking and not thinking, that it is a street and not a river, that the people are not dead yet, and that we are wrong if we think the industry depicted is merely a favorite national pastime. The reader must hunt through the text to find that the scene is probably somewhere in Tokyo—but possibly in Yokohama—and there is no indication as to whether it is before or after the time of any one of several earthquakes, or the time of a change in the building code, or the advent of a particular social influence. The same picture, now serving merely the passing thought of some geographer of Japanese industry, may contain useful information for present or future geologists, engineers, eugenicists and other scientists if given some such title as the following: "*Tokyo.* Shoemakers' quarter on Momachi Street; N.E. toward Matsu-bashi Bridge in distance. 10 A. M. April 18, 1922." A few months later, in the great earthquake, those people *are* dead, and that scene is gone forever. The event may be extreme, but it serves to emphasize the fact that changes are always in progress, and that unusually great ones may supervene at any moment.

The title above suggested is unnecessarily brief, and additional information could advantageously be given to add to the interest and value of the photograph. But it contains the main essentials, and shows that their presentation is not inconsistent with brevity. Given these particulars, many other relative facts could, if necessary, be reconstituted hundreds of years hence. But without these essentials the illustration may be more a burden to the literature than a boon.

Who can doubt that interest attaches to exactness in recording the time and place of photographs which may contribute to a graphic chronology of processes such as soil erosion, shore-line development, climatic change, or human history? The list of phenomena can be indefinitely extended to the point where practically all photographs would be included. It is to be hoped that a widening appreciation of this function of photography will bring a sense of purpose more broadly scientific than now prevails, not only in the choice and description of pictures for publication, but also in their preservation with full titles in collections and chronologic series.

ROBERT VAN V. ANDERSON

ALGIERS

THE CHEMICAL NATURE OF VITAMIN C

The concentration of vitamin C from lemon juice has been continued in a manner similar to that recently described by Svirbely and King,[1] with the additional procedure of recrystallization from organic solvents (*e.g.*, ethyl acetate + petroleum ether). The recrystallized substance corresponds in chemical and physical properties to a hexuronic acid, and is apparently identical with the hexuronic acid described by Szent-Gyorgyi[2] and reported as a reducing factor in adrenal cortex, cabbage and other sources. Feeding approximately 0.5 mg daily protects growing guinea-pigs from scurvy and permits normal vitality in the animals when on a vitamin C-free diet. A detailed account of the experimental work will be published in the near future, but this involves only a few steps beyond the work previously published.

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[1] *Jour. Biol. Chem.*, 94: 483, 1931.

As in all such work, there is a possibility that contaminating active material has adhered to the crystals fed, but that seems unlikely, since the maximum activity has reached an approximate constant with recrystallization, and much of our previous work has indicated such a chemical nature for the active factor.

The recent report of isolation and synthesis of vitamin C by Dr. Ottar Rygh[3] is not in accord with many of our findings, and we believe his experimental results were misinterpreted. It is perhaps sufficient to point out from his paper: (a) That experimental animals receiving his synthetic o-diphenol derivative of narcotine in addition to their basal vitamin C-free diet survived no longer than those receiving the basal diet only; and: (b) That the animals receiving a partial supply of vitamin C in addition to the synthetic compound showed a physiological response not greatly different from that of the group which received only the partial supply of natural vitamin.

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STUDIES IN MOTOR AND MECHANICAL SKILLS

RECENT experimental articles and reviews on the field of "mechanical ability" have advanced important experimental data and widely varying interpretations. The latest review by O. L. Harvey[1] suggests possible reconciliations of the divergent views so far published and in closing suggests that "It might be an interesting piece of research to analyze in terms of the tetrad difference technique the data obtainable from a homogeneous group in response to (a) a test of verbal intelligence, and (b) a combined battery including tests such as (1) the Minnesota assembly and spatial relations tests (for mechanical ability); (2) a selected group of Cox's models, explanations, etc. (for mechanical aptitude); and (3) either the Minnesota tests for steadiness, card sorting, packing blocks and tapping, and Link's machine operators' test or some form of motor skills battery, similar to that developed by Seashore (for motility)."

In view of the numerous discussions aroused in these fields of motor and mechanical performances it may be of interest to note that a study which brings together most of these as well as numerous other measures is now in its second year of progress at the University of Oregon with the assistance of grants-in-aid from the National Research Council and the University of Oregon.

The two main objectives of this research are (1) to determine the interrelations of individual differences in fine and gross motor skills with mechanical skills, and (2) to trace the differentiation of fine motor skills in the early years of life. Tests included in this study are the six motor tests comprising the Stanford Motor Skills Unit[2]; the spatial relations tests, assembly tests and paper form boards from the Minnesota Mechanical Ability Tests; measures of postural steadiness, using the Miles Ataxiameter; measures of arm tremor in two dimensions, using the Beall and Hill Ataxiagraph, a graded series of measures of tapping and other hand and arm motions; simple reaction times to light and sound stimuli; the Cozens tests for measurement of general athletic ability; as well as measures of height and weight. Scores on the A. C. E. College Entrance Test are also available for all observers.

By the end of the present academic year the data on these tests should be complete on fifty male university students and it is hoped to continue the study for a third year in order to have one hundred observers. The desirability of using the tetrad difference technique rests largely upon other findings, which will be discussed in a future article.

In previous studies at Oregon boys of age 6, 10, and 15 years were given shorter lists of the same tests, and data on three motor tests given to preschool children at the University of Iowa are also available. Several studies under way are investigating the stability of the individual differences over long periods of time. Two other studies on the prediction of practical skills in typing and handling of knitting machines indicate that the whole field of aptitude hypotheses must be reformulated to determine the relative importance of selecting personnel, length of training, and improvements of work methods and conditions.

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[2] *Biochem. Jour.*, 22: 1387, 1928.

[3] *Zeit. f. Physiol. Chem.*, 204: 105, 1932.

[1] O. L. Harvey, "Mechanical 'Aptitude' or Mechanical 'Ability'?—A Study in Method," *Jour. of Educ. Psychol.*, 22, 517–22, 1931.

[2] Several studies using this battery have demonstrated the high degree of specificity of its component tests. For this reason it should not be considered a test of "motility" as suggested by Harvey. *Cf.* R. H. Seashore, Stanford Motor Skills Unit., *Psychol. Monographs*, 1928, 39, 51–66; and *ibid.*, "Individual Differences in Motor Skills," *J. General Psychol.*, 3, 38–66, 1930.

Robert H. Seashore
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University of Oregon

HOW BIG IS A CELL?

In classes in elementary biology some attempt is usually made to relate the world revealed by the microscope to the world as we know it with our unaided eyes. In these attempts it has been particularly difficult to compare the scales of the two worlds. For the comparison one needed an every-day object large enough to come within the range of a microscope's field of view. In teaching a class in elementary botany, it occurred to me that the thickness of a page in a book might be so used. The students were asked to determine the figures for themselves, by measuring the thickness of 100 pages of an actual book, dividing by 100 to obtain the value for one page, and then multiplying by 1,000 to convert the reading into microns. Most text-book paper is around 50 microns thick.

In one laboratory course the idea was pushed even further and the students were required during the first exercises with the microscope to rule their drawings with faint lines, 55 microns apart in the scale of the drawing. The finished work then showed what the cells in question would have looked like if seen against the ends of pages in the text-book. I can not be sure that all this was much help to the students, but I have found from experience that it has been very useful to me. Not only has it helped to relate more effectively the two worlds in which I spent most of my time, but it has given me a much better working knowledge of the relative sizes of different plant cells.

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Harvard University

SCIENTIFIC BOOKS

Halley's Comet in its Appearance of 1909–1911. By Nicholas T. Bobrovnikoff. Publications of the Lick Observatory, Vol. XVII, 309 to 482, 1931.

Every one interested in comets to the slightest degree knows of the important papers already published by Bobrovnikoff upon this subject. It is therefore no surprise to find this last perhaps the most complete study of a comet's appearance that has ever been published. Its length and the great detail in which the author describes striking phenomena are justified both by the importance of Halley's Comet, as a typical comet and historically, and by the wealth of data at his disposal.

Working at the Lick Observatory, he used as the basis of his discussion the 438 plates of the comet secured there and 271 selected reproductions from plates taken elsewhere. The former were taken mostly by Dr. Heber D. Curtis, with the writer of the present review much of the time as his assistant. Curtis had intended to work up these himself, but the opportunity for fully doing so never came, though he did publish a preliminary paper (Pub. A.S.P., 22, 117, 1910), and made a number of calculations and notes for the longer one. Therefore Curtis generously turned over everything to Bobrovnikoff, who has, here and there, used some of these calculations in his discussion.

In the space available here, one can call attention to but few of the salient points among the great number of interesting conclusions. The nucleus is proved to have exerted appreciable repulsive forces upon matter forming the jets; in it, however, no rotation was shown, and on several occasions changes of an explosive character were detected therein. For instance, on May 24 a five-fold increase in its size was noted during the exposure of one plate. The threatened breaking up, however, was always followed by a collapse. The jets, composed of cyanogen, were actual matter being expelled. For those in the prolonged radius-vector the nucleus showed repulsive forces of from 1 to 6 times gravitation. The envelopes, in the forms of approximate catenaries, expanded outward at the rate of about half a kilometer per second. The velocity of expansion of the halos was of the same order.

A new determination of the mass of the comet comes out to be of the order of 10^{-10} that of the Earth. This confirms the growing conviction of many of us that some older estimates of the masses of comets were absurdly low. The tail of the comet proved to be double, Tail I having a slight departure from the prolonged radius vector of the orbit, but Tail II making an angle of about 40°. Apparently CO^+ was the chief constituent of Tail I, Tail II shown by diffused solar light and to a lesser degree also by the light of glowing CO^+. In I, the average repulsive forces ranged from 10 to 20, but for the condensations in I these numbers increased to from 20 to 150; in II they were in general < 0.3. He concludes, therefore, that, while the Bessel-Bredichin mechanical theory of comets' tails is sufficient to explain the observed facts, the latter's actual classification is inadequate and that at least four classes are needed, with a great extension of his ideas as to the maximum magnitude of the repulsive forces. It was further shown that not only the nucleus but even knots in the tails were centers of separate activity and repulsive forces, and finally that the assumption that a mass in the tail moves in a hyperbola is only a first approximation; its actual motions seem to be along a series of short paths, under varying repulsive forces.

Only a few trifling typographical errors were detected. The printing is exceptionally good and, for a technical paper, the style is easy and the statements and conclusions clearly made. As a masterly summary of everything that was learned or inferred from the last visit of Halley's Comet the memoir can be highly recommended to every one. It leaves us, however, realizing more than ever how incomplete is our knowledge of the forces acting within a comet and of how evolution ever formed bodies of this type.

CHAS. P. OLIVIER

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The Insect Menace. By L. O. HOWARD. Pages i–xv, 1–347, numerous text illustrations. The Century Company, New York, London, 1931.

THIS is a very readable, interesting account addressed primarily to the thoughtful general public, in spite of the apparently sensational title. The latter is justified by the facts, though comparatively few realize this. There surely is a menace in a group of animals indirectly causing deaths of millions of human beings by disease and starvation. Insects have depopulated considerable sections of the earth and are still maintaining supremacy in certain areas. They certainly can be considered menaces to human welfare.

The author has made a serious effort to interpret to mankind the insect world from the historical or geological, biological and economic aspects, using these terms in a broad sense. This is not a mere discussion of man's history of insects. It outlines the development of this enormous group over a period of forty million years or more and possibly through three hundred million generations, and compares this with the existence of man, extending over some four hundred thousand years and comprising possibly twenty-four thousand generations. It is said that blood tells. Here is a breeding record which shows man as an egotistical upstart, as compared with the earlier, the much more numerous insect dwellers of the earth. In other words, millions of years of existence, the myriad adaptations and the tremendous number of species in all parts of the earth in almost all types of matter clearly demonstrate the ancestral and biological superiority of insects which we, as humans, affect to despise. The evidence forces us to concede biological supremacy to the supposedly lowly insects. The author dwells upon the advantages of the resistant, somewhat elastic, outer walls, known as the exoskeleton to the scientist, calls attention to the great adaptability of insects and also to the extreme prolificacy of these numerous friends and enemies of mankind. In this portion of the book we find many extremely interesting records, not a few of which are relatively new, even to professional entomologists. The book is a remarkable contribution to popular literature on the status of insects and by an outstanding authority in his chosen field. The touch of a master hand and the influence of a broad general knowledge are evident throughout the work.

The problem confronting man, or practical control, is discussed in a comprehensive and extremely interesting manner. Occasional pictures of the experiences of early inhabitants of this country with insects are illuminating and add much to the text. The writer's fifty odd years' experience as a leading economic entomologist in America, in fact in the world, enables him to select the most striking examples of wide-spread depredations, and even death caused by insects. He is better equipped than many another to discuss the basic principles which should be observed in the selection of means for controlling these nefarious and, in some cases, omnipresent pests. There is an interesting and intimate account of the development of quarantine restrictions, with striking sidelights upon the difficulties of enforcing such regulations. There is a discussion of the possibilities and limitations of spraying and the potentialities of biological control. This last appeals greatly to the popular imagination, since it means using insects to kill insects, a subject which is deservedly receiving a great amount of attention at the present time. A distinctly human interest story is related in the account of a search for parasites of the notorious gipsy moth. We find romance in science as well as unselfish devotion to investigation.

There are suggestive accounts of three outstanding efforts to control insects in this country. These deal respectively with the Rocky Mountain locust or Western grasshopper, one of the most terrible pests of the earlier days and even now extremely destructive occasionally, the cotton boll weevil, an outstanding pest in the South in spite of the monument which has been erected to its honor, and the more recent Mediterranean fruit-fly, an introduced insect generally brought to public attention by the press in the last few years on account of its having been discovered in Florida. The excellent series of well-selected illustrations add greatly to the value of the text.

The writer's long experience as a leading economic entomologist and his intimate contacts with leaders in all branches of natural history have enabled him to effectively levy on much general literature usually ignored by specialists, and to cull from such works many extremely interesting details. He has produced a very readable volume, which deals with the broader phase of our relations to insects in such a way as to command the attention of thoughtful people throughout the world. It is not a volume limited to the entomology of the United States or the entomology of the present day. It is world-wide in scope; it contains gems from the writers of earlier days and much attractive to the general reader interested in an authoritative and entertaining discussion of progress in different lines of science.

E. P. Felt

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE HOST INSTITUTION AND HOTEL ACCOMMODATIONS FOR THE SYRACUSE MEETING

The Syracuse meeting of the American Association for the Advancement of Science from June 20 to June 25, the ninetieth of the American Association, and the second annual summer meeting of the new series, will be held under the presidency of Dr. John J. Abel. Syracuse University will be the host institution. Dean Hugh P. Baker, the chairman of the local committee for the Syracuse meeting, has supplied the following information regarding the host institution.

Syracuse University occupies approximately one hundred acres of campus on a hill in the southern section of the city of Syracuse. Its buildings overlook the city's business section, and beyond that Onondaga Lake and the rolling country toward Seneca Lake and Lake Ontario. The elevation is 600 feet above sea level, the prevailing summer breezes are cool, and the climate is healthful.

The university was established in 1871 when Genesee College was moved from Lima, New York, and the city of Syracuse bonded itself in support of a larger institution. The university is not under control of any church denomination; among its important extensions are numbered the Medical College, one of the oldest medical foundations in the state, transferred from Geneva, New York; also a university hospital founded by Bishop Huntington, of the Episcopal Church; and the State College of Forestry, affiliated after the non-denominational character of the university was confirmed. Seventeen separate colleges or educational divisions now make up the institution: they are the Colleges of Agriculture, Applied Science, Business Administration, Fine Arts, Medicine, Law, and Teachers College; and the Schools of Citizenship and Public Affairs, Extension Teaching, Graduate School, Library Science, Nursing, Public Speech and Dramatic Art, and the Summer Session. In all these divisions women share equal privileges with men, though the men outnumber the women by about one thousand.

There are thirty buildings on the campus, several of which have been erected in recent years. Among these are the Hendricks Memorial Chapel; Sims Hall dormitory for men; Slocum Hall, which houses the Colleges of Business Administration, Home Economics, Agriculture, and the School of Citizenship and Public Affairs. The New York State College of Forestry has just completed the Louis Marshall Memorial building and the School of Citizenship expects to be housed in the near future in a building which will be started this spring. The departments of zoology, botany, geology and geography and bacteriology are located in Lyman Hall; Bowne Hall houses the department of chemistry. The third and fourth year medical students, as well as the students who graduated from medicine, are taught in the College of Medicine building. The Good Shepherd Hospital is operated in connection with the College of Medicine. These two units provide the necessary class rooms and laboratories and, in conjunction with the many city hospitals, make for a well-rounded medical unit.

The College of Law holds its courses in Hackett Hall, situated across the street from the county courthouse in the down-town district. The other departments of the university, with the exception of the College of Medicine which is located in the downtown district, are conducted in buildings on the campus between University Place and College Place.

Nearly all the freshmen are housed in dormitories either owned or operated by the university. Sims Hall, dormitory for men, is located on the campus and houses 144 students. Opposite the campus on University Place are Reid Hall, Haven Hall and Winchell Hall, and several smaller dormitories for women.

Although the university has a small endowment, the pressure for admittance continues, despite rigid maintenance of academic standards and increase of tuition charges. This fact is explained by the several currents of student life flowing steadily toward the university, including the original stream of Methodist young people from the towns, villages and farms of central New York, and the added stream of students from the high schools of manufacturing cities, many of them choosing Syracuse because of the opportunities for self help in a city of 210,000 people. The present enrolment is 5,300, exclusive of summer session and extension courses, which bring the total to 10,000.

The administration of the university is encouraging to educational experiment, so that in addition to "projects" now under way at Syracuse supported by four of the great educational foundations, a great deal of reconstruction is going on in curricula, in a cottage system of student housing in individual tutor-adviser work with freshmen, and in a progressive program for intramural athletics.

The Hotel Syracuse has been designated as convention headquarters. The decision has not been made as yet as to whether the university dormitories will be opened for convention guests. Hotel accommodations, together with information concerning the hotels are as follows:

Hotel Syracuse—Harrison, Warren and Onondaga Sts. (608 rooms). Single rooms, $3 to $6.50 per day; double rooms, $4 to $8.50 per day. All rooms with bath.

Onondaga Hotel—Warren and Jefferson Sts. (500 rooms). Single rooms, with or without bath, $2.50 to $6 per day; double rooms, with or without bath, $4 to $9 per day.

Yates Hotel—Montgomery and East Washington Sts. (200 rooms). Single rooms, with or without bath, $1.50 to $3 per day; double rooms, with or without bath, $3.50 to $6 per day.

Jefferson-Clinton Hotel—Jefferson and Clinton Sts. (140 rooms). Single rooms, with or without bath, $2 to $4 per day; double rooms, with or without bath, $4 to $6 per day.

Mispah Inn—Montgomery and Jefferson Sts. (120 rooms). Single rooms, with or without bath, $1.50 to $3 per day; double rooms, with or without bath, $2.75 to $5 per day.

Hotel Hilton—Harrison and Montgomery Sts. (120 rooms). Single rooms, $2.50 to $3.50 per day; double rooms, $3.50 to $5 per day. All rooms with bath.

Hotel Wood—Jefferson and Clinton Sts. (50 rooms). Single rooms, $2 to $3 per day; double rooms, $4 per day. All rooms with bath.

Truax Hotel—Warren and Harrison Sts. (51 rooms). Single rooms, with or without bath, $2 to $2.50 per day; double rooms, with or without bath, $3 to $5 per day.

Kirk Hotel—West Fayette and South Clinton Sts. (31 rooms). Single rooms, with or without bath, $1.50 to $2.50 per day; double rooms, with bath, $4.50 to $5 per day.

The evening lectures are to be held in the large auditorium of Syracuse Central High School. The high school is situated between the down-town district and the university and is within easy walking distance of either the hotels or the university campus. All the hotels given above are centrally located and are within convenient walking distance of the Central High School. All are convenient to direct transportation lines to Syracuse University.

We are assured that a sufficient number of rooms will be reserved by these hotels to accommodate those who attend the Syracuse meeting, but in order to save possible disappointment, members are urged to make their reservations at once. These should be sent direct to the hotels selected.

CHARLES F. ROOS,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE ESTIMATION OF THE HYDROGEN-ION CONCENTRATION OF THE TISSUES IN LIVING ANIMALS

THE great need for suitable methods for the estimation of chemical potentials in the tissues of living animals was emphasized in previous papers from this laboratory.[1] The purpose of this note is to briefly describe a method for the estimation of pH by means of the capillary glass electrode. Further details concerning this method and its application to biological problems will be published in another paper (Public Health Reports). We have previously called attention to the superiority of the glass electrode over other electrodes for the measurement of pH in biological material.[2] The chief advantage of the glass electrode is that it is not affected by the presence of oxidation-reduction systems which are always present in tissues. Another advantage is that the glass electrode can be given almost any desired shape. For the purpose of measuring tissue pH the capillary type is the best, because the glass capillary can be inserted into any of the soft tissues with a minimum of tissue injury.

Special soda lime glass tubing (No. 015 Corning Glass Works) of the following composition is used: SiO_2 72 per cent., CaO 6 per cent., Na_2O 22 per cent. Tubing of approximately 7 mm outside diameter and 1 mm wall thickness is drawn out to a thin-walled capillary, tapering rapidly from the shank. The latter should be about 20 cm in length. The capillary is severed at a distance of 10 to 15 mm from the shank and the tip is carefully sealed in a flame. The work of Kahler and DeEds[3] has shown that the elimination of the so-called hygroscopic "deviation film" on the glass surface above the surface of the system whose pH is to be measured greatly improves the reliability of the glass electrode. The lower surface of the shank is therefore coated with a firmly adhering layer of deKhotinsky cement. The shank is partly filled with a phosphate buffer of about pH 7. The electrode is then connected by means of a pressure rubber tubing to a high vacuum pump. With the electrode in a vertical position, the capillary end being at the bottom, the electrode is evacuated. The air in the capillary is thus completely replaced by buffer. Additional buffer is now added, so as to almost fill the inside of the shank. Fig. 1 illustrates the cross-section of the electrode.

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[1] C. Voegtlin and Floyd DeEds, Public Health Rep., xliii, 380, 1928; H. Kahler, Floyd DeEds, S. M. Rosenthal and C. Voegtlin, *Amer. J. Physiol.*, xci, 225, 1929.

[2] C. Voegtlin, Floyd DeEds and H. Kahler, Public Health Rep., xlv, 2223, 1930.

[3] H. Kahler and Floyd DeEds, *J. Amer. Chem. Soc.*, liii, 2998, 1931.

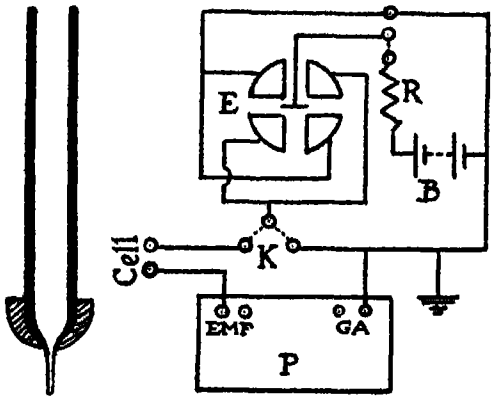

Fig. 1

The next step is to calibrate the electrode by means of two or more pH buffers covering the range of hydrogen-ion concentration of the tissues. We have found phosphate buffers of about pH 7.4 and 6.3, respectively, satisfactory for this purpose. The pH of these standard buffers is carefully determined by the hydrogen electrode at 30° C. The observations of Kahler and DeEds[3] have shown that the potential at an imperfect glass electrode varies slightly if the temperature is raised from 30 to 40°. As the pH of tissues is measured at body temperature, it is therefore necessary to make a temperature correction. This is done by calibrating the glass electrode at 30 and 40° C., or still better at body temperature, in the standard phosphate buffers. Actual experience with several capillary glass electrodes has shown that this temperature correction with phosphate buffers in the physiological range of pH amounts to only a few millivolts. If therefore the electrode is calibrated at body temperature (rectal), it is evident that the error committed can not be significant and certainly will not prevent a fairly accurate measurement of tissue pH. The calibration curve (Voltage—pH) of each glass electrode at body temperature is plotted on coordinate paper. The pH values corresponding to the actual voltage of the tissue at a given time are then read off from these calibration curves.

The animal is given first just sufficient anesthetic (urethane or pentobarbital) for immobilization. The tissue to be measured is exposed, care being taken to avoid bleeding. The surface of the tissue is carefully cleaned with absorbent cotton and the electrode is cautiously inserted and fixed by means of a suitably insulated clamp. The whole length of the glass capillary must be in the tissue. Electrical contact is then rapidly made between the buffer on the inside of the electrode and a saturated calomel half cell by means of a KCl-agar bridge. One end of another agar bridge is placed on exposed and moistened tissue at any suitable part of the animal's body. The other end of this bridge leads to a second saturated calomel half cell. The other electrical connections are shown in Fig. 1. The measuring equipment consists of a Compton electrometer and a Leeds and Northrup type K potentiometer. For purposes of proper screening the animal and potentiometer are placed in a grounded wire cage. During moist weather it is essential to lower the humidity of the room air in order to prevent electrical leaks. This can be accomplished in a manner previously described.[1]

It is obvious that only such potential readings in the tissues are of value which are not accompanied by more than relatively slight time drifts. In numerous experiments done with this new method it was found that careful observation of all necessary precautions will eliminate drifts exceeding those shown in the following table. In some experiments, however, larger drifts occur, and these results are rejected. It appears that this drift may result from the following causes: (1) Injury of blood vessels; (2) imperfect immobilization of the tissue and consequent progressive tissue injury from continuous motion of the electrode in the tissue due to respiratory movements; (3) blood films over the tissue through which the electrode is inserted.

It may be stated, however, that the results as a rule are surprisingly satisfactory, considering the obvious difficulties which are involved in the application of this method. Further work is necessary to ascertain the experimental error of this technique. We believe, however, that sufficient repetition of the measurements of a given tissue with several accurately calibrated electrodes probably involves average errors not exceeding 0.05 pH. The most reliable results are obtained by selecting from a set of electrodes those which give the best results on calibration in the standard buffers, *i.e.*, a nearly theoretical calibration.

To illustrate the technique the results of the following experiments dealing with the estimation of the pH of the Rous chicken sarcoma No. 1 are given.

pH OF ROUS CHICKEN SARCOMA

Subcutaneous tumor No. 1		Subcutaneous tumor No. 2		Large intramuscular tumor No. 1	
Minutes	pH	Minutes	pH	Minutes	pH
1	6.76	3	6.89	2	6.42
3	6.76	5	6.87	4	6.49
5	6.73	7	6.85	5	6.47
8	6.76	10	6.84	9	6.42
11	6.76	16	6.82	13	6.32
13	6.78	30	6.79	16	6.32
		61	6.79	18	6.32
		95	6.80		
		125	6.82		

These results indicate that the Rous chicken sarcoma in the living animal is characterized by an extremely low pH, as compared with that of blood. Work with the Jensen rat sarcoma and the Walker rat carcinoma 256 has also revealed pH values considerably on the acid side of 7. These very significant observations have led us to a systematic investigation of the pH of a great variety of normal and malignant tissues in the living animal.

Since October, 1931, Dr. R. H. Fitch has joined us in this work and we are indebted to him for assistance in the final development of this new method.

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A CULTURE MEDIUM FOR PARAMECIUM

THE medium set forth in this article has proven itself to be very satisfactory in the culturing of various species of Paramecium in pure line cultures. The main result of the use of the medium is that the organisms do not exhibit a lowering of their normal metabolism after continuous culturing.

The basic part of the medium is the usual hay infusion of ten grams of chopped timothy hay boiled for fifteen minutes in a liter of well water. This infusion is filtered and sterilized in the Arnold steriliser at 100° C. one hour a day for three days. It is diluted with nine volumes of sterile well water just before using. Two portions of this infusion are placed in sterile liter flasks with sterile cotton stoppers. One liter is inoculated with *Bacillus subtilis* and the second with *B. coli communis*. A third portion of the medium is made up as follows: Approximately thirty grains of wheat are boiled in a small amount of water for ten minutes. The wheat grains only are then placed in a third liter flask of sterile well water. The three portions are incubated at 37° C. for twenty-four hours, and then combined in one large sterile flask. The medium is now ready for use. The cultures may be used in almost any size of container, but that used has been the three hundred cc Erlenmeyer flask. These flasks are fitted with cotton stoppers and sterilized. Each flask is filled about two thirds full of the medium, and different species of Paramecium are transferred to the cultures with sterile pipettes.

The original basic infusion may be made up, sterilized and stored in a refrigerator until ready for use. Likewise, the medium, made of the three portions, may be stored in a refrigerator for later use.

Sterile precautions are maintained throughout the procedure, but after Paramecium has been transplanted, such strict precautions are no longer necessary. The essential part of the process is to provide a medium rich with a suitable food in which Paramecium will continue to grow normally. With these sterile precautions, other ciliates and flagellates are eliminated. A single organism placed in such a medium will produce a flourishing culture in seven to ten days. One should transplant every two to three weeks. *Paramecium multimicronucleatum*, *P. bursaria* and *P. aurelia* have been thriving for eight months in this medium.

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SPECIAL ARTICLES

SIZE OF INFECTION AS AN INFLUENCE ON THE PERSISTENCE OF ADULT TRICHINAE IN RATS[1]

THE statements that can be found in text-books and published work on trichiniasis regarding the length of life of adult *Trichinella spiralis* are usually quite vague and indicate that wide variations may occur. The usual statement is that the adult worms live for several weeks or longer. Ransom[2] says that adult trichinae of both sexes have been found in the intestine as late as 12 weeks after infection, and that they may commonly be found in large numbers for as long as 7 weeks. On the other hand, Christenson[3] in a series of experimentally infected rats did not find any adults after the sixteenth day and concluded that 16 days is about the normal duration of the worms in the intestine.

---

[1] From the laboratory of parasitology, department of bacteriology, University of Rochester, School of Medicine and Dentistry, Rochester, N. Y. This investigation was aided by a grant from the Rockefeller Foundation.

[2] B. H. Ransom, "Trichinosis," Rep. U. S. Live Stock San. Assoc., pp. 147–165, 1915.

In the study of a large number of rats experimentally infected with trichiniasis the writer has found that the size of infection has a great influence on the length of time that the adult worms persist in the intestine. All rats were infected by stomach tube with known numbers of larvae obtained free from infected muscle by artificial digestion. The doses were administered according to the body weight of the animals.

In light infections of 20 larvae per gram, or less, the adult worms were never found in appreciable numbers after the fifteenth day after infection. When these rats were killed after 4 weeks only full-grown larvae could be found in the muscles. On the other hand following a much larger dose (40 or 50 larvae per gram) larvae in all stages of development could nearly always be found in the muscles for as long as 4 or 5 weeks after infection. Some of them were of a size which indicated that they had but recently migrated. Upon examination of the intestines of these rats considerable numbers of adult trichinae were usually found to be still present. These observations were consistently made in a large number of rats that died from trichiniasis 4 to 6 weeks after infection.

The following table gives the results of an experiment in which rats receiving doses of 20 and 50 larvae per gram were killed at intervals up to 3 weeks after infection. Very few adult worms were found in two rats given 20 larvae per gram and killed on the fourteenth day after infection. None at all were found in two more of this group killed on the twenty-first day. On the other hand, 25 to 50 per cent. of the original number of larvae fed were still present as adult worms in the intestines of the rats given 50 larvae per gram and killed after 14 and 21 days.

The most plausible explanation of these observations seems to be that a heavy infection breaks down a resistance in the rats which ordinarily limits the duration of the adult trichinae in the intestine. The size of infection which best illustrates this effect is one which does not kill the rats until after the fourth week. If the infection is too large, the animals die within two weeks in the intestinal stage of the disease. If it is not large enough, the resistance is not broken sufficiently and the animals recover.

No doubt there are other factors, such as diet, health of the animal, etc., which might influence the resistance of the rats and the length of life of the adult trichinae. Other experiments, also, indicate that the infection behaves differently in different hosts. Apparently guinea-pigs have very little resistance against trichiniasis, for the lethal dose of larvae is much smaller than for rats and the adult worms live for as long as 5 weeks following doses as small as 5 larvae per gram. The infection in rabbits, on the other hand, apparently behaves much the same as in rats. It will be interesting to compare the parasitological course of trichiniasis in a larger series of hosts, including man.

TABLE I

SURVIVAL OF ADULT TRICHINAE IN RATS GIVEN DIFFERENT SIZED DOSES OF LARVAE

20 larvae per gram	No. of larvae fed	Killed—days after infection	No. of adults in intestine	Per cent. of original dose
Rat no. 1	4,200	5 days	2,960	71
" " 2	4,140	5 "	2,920	71
" " 3	3,540	5 "	2,660	75
" " 4	3,600	14 "	30	1
" " 5	3,900	14 "	570	15
" " 6	4,920	21 "	0	0
" " 7	5,800	21 "	0	0
50 larvae per gram				
Rat no. 8	10,800	5 days	5,220	48
" " 9	9,100	5 "	4,640	51
" " 10	11,500	5 "	6,420	56
" " 11	10,400	14 "	5,700	55
" " 12	12,400	14 "	5,850	47
" " 13	9,800	21 "	4,800	49
" " 14	9,700	21 "	2,400	25

These observations that the rat possesses a "normal resistance" against trichina infection fall in line with other experiments[4] which show that rats can develop an immunity to reinfection with *Trichinella spiralis*. They also add to the evidence that has been piling up of late that host factors can play an important rôle in determining the course of helminth infections. In any event, they offer a probable explanation of the variations in the reported length of life of adult trichinae.

O. R. McCoy

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[3] R. O. Christenson, "The Sex Ratio of Adult Trichinae," SCIENCE, 66: 259, 1927.

[4] O. R. McCoy, "Immunity of Rats to Reinfection with *Trichinella spiralis*," *Am. Jour. of Hyg.*, 14: 484–494, 1931.

SUCCESSION OF FORESTS AS INDICATED BY FOSSIL POLLEN FROM A NORTHERN MICHIGAN BOG

The study of fossil pollen and the history of past forests linked up with it has claimed considerable attention among botanists here and in Europe. The present paper is part of the research on peat from Bryant's Bog, one of the deepest bogs near Douglas Lake, Cheboygan County, Michigan. The work was carried on during the summer of 1931 at the Biological Station of the University of Michigan, under the direction of Professor F. C. Gates.

Bryant's Bog is evidently an old glacial kettle-lake, approximately 65 feet deep. Up to a few years ago the adjacent plain and upland were covered with virgin deciduous forest, most of the region, otherwise, was covered with pine. Collection of peat was made at one foot intervals to a depth of 20 feet.

The customary method of pollen investigation seems to be to boil the peat in KOH to separate the pollen from the débris. The writer tried to avoid this treatment of the peat, as it frequently distorts the pollen grains. Northern Michigan peat is usually very moist and not densely packed, so that the KOH treatment would hardly be necessary. The fossil pollen grains of these bogs are in an excellent state of preservation. The peat was placed in a glass vial as soon as it was taken from the chamber of the borer; separation of the material was made by the addition of distilled water just before the count was made.

In preparing the slide, a scalpel-tipful of peat was moistened with water and the well-stirred mass scraped to one end of the slide while it was being held on a slant. When sufficient liquid had drained from the coarser particles, a cover-glass was placed over the fluid and counting was made from this preparation. An area covered by an 18 x 18 mm cover always permitted a count of 100 pollen grains. Two sets of 100 counts each were made for every level. As specimens of pollen grains of present-day plants were not available in sufficient number of species to make absolute identification of the fossil pollen possible, a comparison was made of the proportions of pollens of conifers and of deciduous trees and herbaceous plants at the different levels in the peat.

Pollen of conifers was very scarce in the upper layers of the peat and very abundant from the 9-foot level on, being most abundant at the 10-foot level. In a way this record presented a remarkable picture of the floristic aspect of the region, both of the present and the past; especially since it correlated with that part of the past which has left other records to the present. Ring counts made by Professor F. C. Gates when the deciduous woods was cut showed an age of 370 to 400 years for the oldest hardwood trees in the region. Assuming approximately 100 years for deposition of two feet of peat, the pollen record showing dominance of the deciduous forest correlates with the time indicated by the ring count. According to the record presented by the deeper layers of peat, conifers controlled the area about 1,000 years ago, after which for some reason deciduous trees invaded the region and held this position to the time when white men first knew the forest. The sudden dip from coniferous to deciduous pollen dominance between the 9- and 10-foot levels even suggests the possibility that some factor destructive to the then dominant forest aided the invader in rapid ecesis.

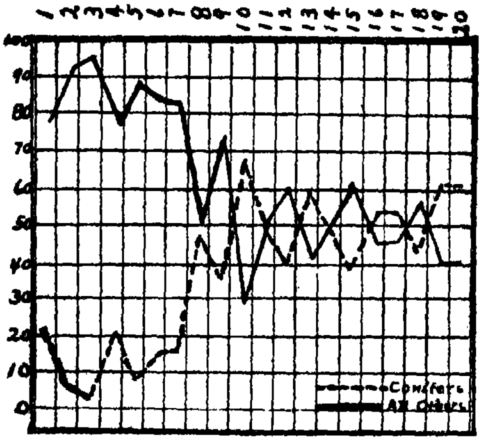

Fig. 1. Showing comparison of the percentage of pollen of conifers against all other pollen present in peat from Bryant's Bog. Horizontal lines percentage pollen. Vertical lines level of peat.

J. E. Potzger,
Research Fellow at Indiana University
Bloomington, Indiana

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SCIENCE

VOL. 75 FRIDAY, APRIL 8, 1932 No. 1945

Models of the Physical Universe: PROFESSOR RICHARD C. TOLMAN 367

Obituary:
Wilson Alwyn Bentley: W. J. HUMPHREYS. *Memorials. Recent Deaths* 374

Scientific Events:
Macaulay Institute for Soil Research; The Edward Orton, Jr., Ceramic Foundation; Marine Expedition to the West Indies; The Pullman Meeting of the Pacific Division of the American Association 375

Scientific Notes and News 377

Discussion:
Biological Abstracts and the College: DR. HOPE HIBBARD. *Thallium Poisoning:* DR. MARCUS WARD LYON, JR. *Extra-Pancreatic Insulin in the Dog after Pancreatectomy?:* DR. SAMUEL SOSKIN. *The Muskrat, a New Host for Paragonimus:* DONALD J. AMEEL. *Conical Snow:* THE LATE WILSON A. BENTLEY. *Relations between Fundamental Physical Constants:* PROFESSOR RAYMOND T. BIRGE 380

Special Correspondence:
The Philadelphia Institute for Medical Research: PROFESSOR JUDSON DALAND 383

Quotations:
On the Relation between the Expansion and the Mean Density of the Universe 384

Reports:
Science Essays by High School Pupils: DR. OTIS W. CALDWELL 385

Scientific Apparatus and Laboratory Methods:
A Rapid Method for Obtaining Single Spore Cultures of Molds: H. C. GREENE and PROFESSOR E. M. GILBERT. *A Method for Determining the Volume of Small Pieces of Tissue:* DR. H. S. RUBINSTEIN. *Aloxite as an Abrasive for Grinding Bone Sections for Histological Purposes:* EDMOND J. FARRIS 388

Special Articles:
The Centriole of the Amphibian Leucocyte: DR. ARTHUR W. POLLISTER. *Leaf Temperatures of Cotton Plants with Phymatotrichum Root Rot:* DR. WALTER N. EZEKIEL AND DR. J. J. TAUBENHAUS 390

Science News 8

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MODELS OF THE PHYSICAL UNIVERSE[1]

By Professor RICHARD C. TOLMAN

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INTRODUCTION

FIRST of all, I wish to express my thanks to Professor Boodin and to Professor Miller for suggesting that the Philosophical Union might be interested in some of the recent work of theoretical physicists in the field of cosmology. More than two thousand years ago, at the instigation of Aristotle, scientific expeditions were financed by Alexander the Great to explore the countries which he had conquered and report their findings to the great philosopher and his school[2]; and in coming as a scientist to report to you—who are philosophers—I feel that I am acting in accordance with an honorable and desirable tradition.

Nevertheless, certain changes have occurred in the relations between science and philosophy since the golden time of Aristotle which must not be overlooked.

In the first place, philosophy and science are no longer a united study, and it is not the philosophers but the scientists themselves who now organize and direct their own explorations. Indeed, I think it would have been an unhappy day for science if Galileo had not broken from the Aristotelian tradition, and in any case, whether for better or worse, science has long since issued a declaration of independence from philosophy which can not now be disregarded.

In the second place, the developments of philosophy and science have in the meantime been so extensive and complicated that both disciplines and even their separate branches have been forced to invent special technical languages for the discussion of their subject-matters. Indeed, I have heard a humorous, and I trust untrue, definition of philosophy which reads: "Philosophie ist der systematische Misbrauch einer eigens zu diesem Zwecke erfundenen Terminologie."[3] However this may be, it is abundantly evident that scientists and philosophers now have almost insurmountable difficulties in talking with each other, and indeed among themselves, because of a new Babel of tongues.

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[1] Address before the Philosophical Union, University of California at Los Angeles, February 17, 1932.

[2] See Pliny, "Hist. Nat.," VIII, 16.

This afternoon I am particularly impressed by this latter difficulty, since I wish to describe to you, in ordinary English, results which can only be obtained by using the language of a special and somewhat complicated branch of mathematics. For this reason I shall confine my mathematics to a few equations which will be projected on the screen, and shall be forced, I am afraid, to say some things which are not very detailed and precise but which will I hope convey a moderately correct impression.

THE PROBLEM OF COSMOLOGY

For the scientist the problem of cosmology lies in an attempt to describe and understand the structure and behavior of the physical universe as a whole, looked at from a large-scale point of view which considers the average distribution and properties of the matter and radiation of which the universe is constructed, but neglects local details such as the structure of our own earth and solar system, or even the particular arrangement of stars in our own galaxy. Indeed, the scale of view is so large that the contents of the universe are in some ways treated like a fluid with the stars taking the place of atoms and the galaxies or nebulae playing the rôle of molecules.

The method of attacking this problem of cosmology is twofold, observational and theoretical.

For the observational material we must depend on the astronomer, in particular on the remarkable work of Hubble at the Mount Wilson Observatory. With the 100-inch telescope it has been possible to penetrate to a depth of about 10^8 (one hundred million) light-years, way beyond the limits of our own galaxy of stars, whose diameter is only of the order of 10^5 (one hundred thousand) light-years. Scattered throughout all this region at great distances from one another we find numerous nebulae, some millions in all, which themselves appear to be great collections of stars similar to our own milky way. These nebulae are grouped to a certain extent in clusters, but from a large-scale point of view they may be regarded as distributed with a reasonable uniformity, and in particular show no tendency to decrease in concentration as we go farther and farther out into space. A specially important characteristic in the light from the nebulae is a shift towards the red in the position of their spectral lines, this red shift increasing proportionally to the distance out to the nebula. As to the contents of extra-galactic space other than the nebulae, for example, dust and radiation, we can say very little. Owing to the great volume of space between the nebulae, Hubble estimates that the amount of matter spread out in the universe in the form of dust could be several thousand times as great as that concentrated in the nebulae themselves, without producing effects which so far would have been detected. And on the other hand, I have calculated that the temperature of intergalactic space would only have to be 12 degrees absolute to give a density of radiation as large as Hubble's averaged out density of matter.

The theoretical method of treating the problem of cosmology is the one which we are to discuss this afternoon. It has three tasks: first, the interpretation of the findings of the astronomer in terms of accepted or acceptable theory; second, the extrapolation of the findings of the astronomer farther out into space and forward and backward in time together with the prediction of additional phenomena; and third, investigations to determine the conceivable properties which the universe could have in accordance with satisfactory theory.

All three of these tasks are attacked by constructing conceptual models of the universe, in accordance with the principles of theoretical physics, and then investigating the properties and behavior of these theoretical models, for purposes of comparison with what we know or might find in the actual universe. These models are highly abstract and idealized, as contrasted with the actual universe; indeed, they have to be in order to make it possible to treat them with the mathematics at our disposal. When our main interest lies in the interpretation or extrapolation of some property of the actual universe, which has already been observed by the astronomer, we construct conceptual models which exhibit this property and of course as far as possible the other known properties of the actual universe. But when we are searching for the conceivable properties which the universe could have and which might sometime become subject to observation, we allow ourselves great latitude in the kind of models that we study. For example, even though the actual universe is known to contain matter, we may find it informing to consider the properties of a cosmological model which is completely empty, as was done by de Sitter, or one which contains nothing but radiation, as has been done by Silberstein and by myself.

THE PRINCIPLES FOR CONSTRUCTING THE MODELS

We must now inquire into the principles on which the cosmological models are to be constructed. This is a matter of the greatest importance, since the chief difference between the work of the theoretical scientist in trying to understand the properties and behavior of the universe and the fantastic speculations of amateur cranks lies in the attempt of the scientist to make his considerations conform to a satisfactory theory.

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[3] Told to me by my colleague, Professor Fritz Zwicky. "Philosophy is the systematical misuse of a terminology specifically invented for this purpose."

The first requirement for the construction of acceptable cosmological models is that they shall conform to the principles of mechanics. For this purpose it is not sufficient to use the classical mechanics of Newton, which has been found to give a correct description of mechanical phenomena in a limited region of space and in the absence of strong gravitational fields. It is necessary, instead, to use the relativistic mechanics of Einstein, which contains the Newtonian mechanics as an approximation, and in addition meets the three so-called crucial tests of relativity, by giving correct predictions of the motion of the perihelion of Mercury, of the bending of light in passing the sun and of the shift in the wave-length of light that originates in a strong gravitational field.

It would be too difficult and time-consuming a task to try to give a logical presentation of the axioms of relativistic mechanics and their physical interpretation. I may call your attention, however, to some of the fundamental equations.

The space-time continuum in which physical events take place is regarded as characterized by a line element of the form

$$\begin{aligned} ds^2 &= g_{11}dx_1^2 + 2g_{12}dx_1dx_2 + \cdots + g_{44}dx_4^2 \\ &= g_{\mu\nu}dx_\mu dx_\nu \qquad (g_{\mu\nu} = g_{\nu\mu}) \end{aligned} \tag{1}$$

where x_1, x_2, x_3 and x_4 are the spatial and temporal coordinates and the $g_{\mu\nu}$ are the ten gravitational potentials. The motion of light rays and material particles in this space-time is given by the equations

$$ds = 0 \qquad \text{(For light rays)} \tag{2}$$

$$\delta\int ds = 0 \qquad \text{(For particles)} \tag{3}$$

And the dependence of the gravitational potentials on the distribution of matter and energy is given by the ten equations

$$-8\pi T_{\mu\nu} = G_{\mu\nu} - \tfrac{1}{2}Gg_{\mu\nu} + \Lambda g_{\mu\nu} \tag{4}$$

where $T_{\mu\nu}$ is the energy-momentum tensor, $G_{\mu\nu}$ and G are obtained from the Riemann-Christoffel tensor by contraction, and Λ is the so-called cosmological constant. Although the precise value of the quantity Λ is unknown, we do have observational evidence that shows that it is in any case a very small quantity. Hence we should prefer to take it zero if possible.

In addition to applying relativistic mechanics in the construction of cosmological models, I have found that it is also necessary to apply the principles of relativistic thermodynamics. For this purpose an extension of thermodynamics to general relativity was needed. To obtain this[4] I have taken as the analogue of the first law of classical thermodynamics the known relativistic equation

$$\frac{d\mathfrak{T}_\mu^\nu}{dx_\nu} - \tfrac{1}{2}\mathfrak{T}^{\alpha\beta}\frac{dg_{\alpha\beta}}{dx_\mu} = 0 \tag{5}$$

which corresponds in relativistic mechanics to the classical principles of the conservation of energy and momentum. And I have taken as the analogue of the classical second law of thermodynamics an expression

$$\frac{d}{dx_\mu}\left(\varphi_0\sqrt{-g}\,\frac{dx_\mu}{ds}\right)dx_1\,dx_2\,dx_3\,dx_4 \geqq \frac{dQ_0}{T_0} \tag{6}$$

which can be shown to be a covariant generalization of the usual second law. The quantity φ_0 in this expression is the proper entropy density of the thermodynamic fluid as measured by a local observer, the quantities dx_μ/ds the components of the macroscopic "velocity" of the fluid, dQ_0 the heat as measured in proper units flowing into the region $dx_1\ dx_2\ dx_3$ in the time dx_4, and T_0 the proper temperature. The equals sign (=) applies to reversible processes and the sign "is greater than" (>) to irreversible processes.

STATIC COSMOLOGICAL MODELS

Let us now turn to the actual cosmological models that have been constructed in accordance with these principles.

The first of these was the famous static model of Einstein[5] with the line element

$$ds^2 = -\frac{dr^2}{1 - r^2/R^2} - r^2d\theta^2 - r^2\sin^2\theta d\varphi^2 + dt^2 \tag{7}$$

where R, the so-called "radius" of the model, is a constant. This line element corresponds to a permanent uniform distribution of matter and energy, having from a large-scale point of view the pressure p and density ρ as given by the equations

$$8\pi p = -\frac{1}{R^2} + \Lambda \tag{8}$$

$$8\pi\rho = \frac{3}{R^2} - \Lambda \tag{9}$$

Although the study of this model has been very instructive, two objections to it may be immediately mentioned. In the first place being a static model it prescribes a state of rest for the heavenly bodies and gives no account of the apparent recession of the nebulae as shown by the red-shift in the lines of their spectra. And in the second place it necessitates a positive value of the cosmological constant Λ to prevent the expression for the pressure from becoming negative, and as mentioned before we should be glad to set $\Lambda = 0$ if possible.

---

[4] Tolman, *Proc. Nat. Acad.*, 14, 268, 701, 1928; *Phys. Rev.*, 35, 876, 896, 1930.

[5] Einstein, "Berl. Ber.," p. 142, 1917.

The second relativistic cosmological model to be constructed was that of de Sitter[6] with the line element

$$ds^2 = -\frac{dr^2}{1 - r^2/R^2} - r^2 d\theta^2 - r^2 \sin^2\theta d\varphi^2 + (1 - r^2/R^2)dt^2 \quad (10)$$

where the radius R is connected with the cosmological constant by the equation

$$\frac{3}{R^2} = \Lambda \quad (11)$$

and the line element corresponds to a completely empty universe with the pressure and density everywhere both equal to zero

$$p = \rho = 0 \quad (12)$$

The most immediate objection to this model is of course its complete emptiness, which means that the matter in our actual universe would produce some distortion away from the proposed form. Furthermore, although it was found that particles introduced into such a universe would undergo complicated motions, provided Λ was not set equal to zero, a good explanation accounting both for the red-shift and the density of distribution of the nebulae was not obtained with this model.

NON-STATIC COSMOLOGICAL MODELS

The two line elements of Einstein and de Sitter are called static, since the gravitational potentials $g_{\mu\nu}$ do not depend on the time. Since neither of these models is found to agree with observational facts, it is first natural to inquire if perhaps some other static line element would give an explanation of the red-shift. Some years ago, however, I found[7] it possible to prove that the Einstein line element and the de Sitter line element are the only possible *static* ones which would correspond to a universe having homogeneous properties throughout, and suggested that the study of *non-static* line elements would be very interesting, especially since static line elements take no explicit cognizance of any general evolutionary processes that may be occurring in the actual universe.

As a matter of fact, such studies had already been initiated by a gifted Russian, Friedman,[8] who had given in 1922 an expression for the very non-static line element that is now the subject of so much investigation. The derivation which he gave for the line element is not entirely satisfying, and he considered no direct physical application of his results. He had, however, a masterful grasp of the problem and in spite of the lack of attention that has been paid to his article should receive credit as the originator of the new chapter in cosmology.

This non-static line element can be written in the form

$$ds^2 = -e^{g(t)}\left(\frac{dr^2}{1 - r^2/R^2} + r^2 d\theta^2 + r^2 \sin^2\theta d\varphi^2\right) + dt^2 \quad (13)$$

where R is a constant and the dependence of the line element on the time is given by the exponent g(t). This line element corresponds to a homogeneous distribution of matter and energy having the pressure p and density ρ

$$8\pi p = -\frac{1}{R^2} e^{-g} - \frac{d^2g}{dt^2} - \tfrac{3}{4}\left(\frac{dg}{dt}\right)^2 + \Lambda \quad (14)$$

$$8\pi\rho = \frac{3}{R^2} e^{-g} + \tfrac{3}{4}\left(\frac{dg}{dt}\right)^2 - \Lambda \quad (15)$$

which will in general be changing with the time owing to their dependence on the quantity g, which is itself a function of the time. As has been specially emphasized by Einstein, this line element would not require a value of Λ differing from zero in order to prevent the pressure from becoming negative provided d^2g/dt^2 is negative.

The first application of this non-static line element to the phenomena of the actual universe was made by Abbé Lemaitre,[9] of the University of Louvain, who noted that the line element would correspond to an expanding model of the universe if g is increasing with the time, and showed that this would permit an immediate explanation of the mysterious red-shift in the light from the nebulae, since in an expanding universe the nebulae would be moving away from us and this would be expected to increase the wavelength of the light that we receive from them by what is known as the Doppler effect. His detailed treatment contained an unnecessary and improbable assumption as to the value of the cosmological constant Λ, and a specialization which would rule out the presence of radiation and the transformation of matter into radiation in the universe; but the important discovery that the red-shift in the light from the nebulae can be interpreted with the help of an expanding model of the universe is due to him.

The work of Lemaitre was followed by a very fundamental article by Professor Robertson,[10] of Princeton, giving a derivation of the non-static line element for the universe based on very general mathematical assumptions, and by a derivation of my own[11] based on the physical assumption that we can regard the material filling the universe, from a large-scale point of view, as having uniform properties at a given time throughout the whole of space. At the time I did not know of the previous work that had been done in this field and was led to investigate non-static models from the consideration that the transformation of matter into radiation, which appears to be taking place everywhere throughout the universe, would necessarily lead to a non-static line element. The result obtained showed that it was possible to account both for the transformation of matter and the recession of the nebulae with the help of a non-static line element.

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[6] de Sitter, *Monthly Notices, R.A.S.*, 76, 77, 78, 1916–1917.

[7] Tolman, *Proc. Nat. Acad.*, 15, 297, 1929.

[8] Friedman, *Zeit. Phys.*, 10, 377, 1922.

[9] Lemaitre, *Ann. Soc. Sci. Bruxelles*, 47, Series A, 49, 1927.

[10] Robertson, *Proc. Nat. Acad.*, 15, 822, 1929.

[11] Tolman, *Proc. Nat. Acad.*, 16, 320, 1930.

A very powerful additional argument in favor of the non-static line element for the universe was then presented by Eddington,[12] who showed that even if we should start with a static Einstein model of the universe, this would be unstable and would change to a non-static model as the result of small disturbances. The non-static line element for the universe was then also considered by de Sitter[13] who calculated the theoretical course of expansion and contraction for a large number of different conceptual models, assuming that the transformation of matter into radiation could be neglected and assuming the general form of the non-static line element, but making different assumptions as to the unknown quantities R and Λ in the equations.

Since then there have been many further articles[14] on the non-static line element, not only because there are many special problems to be considered into which we can not go here, but also because our knowledge of the actual universe is still too limited to allow a decision between different specific possibilities which would be in accord with the general form of the non-static line element. For this latter reason it is profitable for the theoretical physicist to consider many different conceptual possibilities as to the universe, in advance, and perhaps sometimes generations in advance, of the observational possibilities available to the astronomer. As a result of all the work that has been done, nevertheless, there has grown the increasing conviction that it is an entirely sensible procedure to attempt to explain the once mysterious red-shift in the light from the extra-galactic nebulae as due to an expansion of the universe, or, at the least, of that part of the universe which we have so far observed.

APPLICATION OF RELATIVISTIC THERMODYNAMICS TO COSMOLOGICAL MODELS

The foregoing studies of cosmological models have all been based on relativistic mechanics. To complete our considerations we must also consider the thermodynamic aspects of their behavior. This has appeared specially important to me and has engaged a good deal of my attention.

In the case of the older static models no thermodynamic studies were necessary, since nothing at all ever happened in these static models. In the case of the newer non-static models, however, we must *inquire into the compatibility of their behavior* not only with the principles of relativistic mechanics, and hence with the relativistic form of the first law of thermodynamics, but also as to compatibility with the relativistic form of the second law of thermodynamics. By doing so we gain, I think, two important extensions in our ideas as to the kind of process which might take place in the universe, without contradicting the rules enforced by that disintegrating ogre, the second law of thermodynamics.

The first of these extensions has to do with the occurrence of thermodynamically reversible processes, that is, processes which take place without increase in entropy and without dissipation of energy. In the classical thermodynamics, disregarding purely mechanical changes, it was found that no processes could take place both at a finite rate and at the same time reversibly without increase in entropy. To make processes reversible, it was found necessary to carry them out at an infinitesimally slow rate, in order to obtain, so to speak, the perfect efficiency necessary for reversibility. In relativistic thermodynamics, however, we find a possibility for certain reversible processes to take place both at a finite rate and without increase in entropy, owing to the possibility of correlated changes in entropy density and gravitational field which were neglected in the older theory. This is a matter of some importance, since in the past we have felt that we would be obliged to interpret any thermodynamic change taking place in the universe at a finite rate as evidence that the universe was necessarily running down.

I have considered this new possibility in connection with two different conceptual non-static models of the universe,—one containing nothing but radiation,[15] and the other containing an equilibrium mixture of radiation and perfect gas.[16] It was found that both of these models could expand or contract at a finite rate and yet reversibly without increase in entropy —the first necessarily so, and the second under the additional assumption that the rates of transformation of matter into radiation and the reverse were fast enough to maintain equilibrium conditions. It was also shown that there would be a number of phenomena in these models, such, for example, as the outward flow of radiation in an expanding model, which would be interpreted by an ordinary observer familiar only with the classical thermodynamics as definite evidence for the irreversible dissipation of energy into the "cold depths" of space, in spite of the fact that from the more legitimate point of view of relativistic thermodynamics everything would really be taking place entirely reversibly.

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[12] Eddington, *Monthly Notices, R.A.S.*, 90, 668, 1930.

[13] de Sitter, *Bull. Astron. Inst. Netherlands*, 5, 211, 1930; *ibid.*, 6, 141, 1931.

[14] Tolman, *Proc. Nat. Acad.*, 16, 409, 1930; *ibid.*, 16, 511, 1930; *ibid.*, 16, 582, 1930; McRae and McVittie, *Monthly Notices, R.A.S.*, 91, 128, 1930; McVittie, *Monthly Notices, R.A.S.*, 91, 274, 1930; Laue, *Naturwiss.*, 19, 530, 1931; Einstein, "Berl. Ber.," p. 235, 1931; Takĕuchi, Proc. Phys. Math. Soc. Japan 13, 166, 1931; Heckmann, *Nachr. Wiss. Goettingen*, II, p. 126, 1931; McRae and McVittie, *Monthly Notices, R.A.S.*, 92, 7, 1931.

[15] Tolman, *Phys. Rev.*, 37, 1639, 1931.

[16] Tolman, *Phys. Rev.*, 38, 797, 1931.

It is also to be noted that in the case of processes which take place reversibly without increase in entropy there would be no thermodynamic hindrance to a repetition of the same process over and over again. And, indeed, in the case of the two models just mentioned I have been able to show that they could undergo a continued succession of identical expansions and contractions, without ever coming to a state of rest, provided the cosmological constant in Einstein's equations is zero or negative.[17]

The second extension provided by relativistic thermodynamics in our ideas as to the kind of changes that can take place without contradicting the second law of thermodynamics has to do with the results to be expected when irreversible processes take place. The consideration of irreversible processes is very necessary, since, although we can imitate some of the important phenomena in the actual universe with the help of models that change reversibly, it is evident that reversible processes form only a limited class of the totality of conceivable thermodynamic processes. And we can not expect that the phenomena of the actual universe are all of them really reversible.

In accordance with the classical thermodynamics, when irreversible processes take place in an isolated system, the energy of the system has to remain constant on account of its isolation, and the entropy can then only increase to the upper maximum value which is consonant with this energy. This upper limit corresponds to the most probable internal arrangement of the system attainable with the fixed amount of energy available, and when this limit is reached no further changes would be possible. Hence the classical thermodynamics has accustomed us to believe that the entropy increases taking place in the universe are leading towards a final run-down condition of maximum entropy where all change would cease—the sun and stars cold, all of creation dead and lifeless.

In relativistic thermodynamics, however, a different condition of affairs arises, owing to the fact that the principles of relativity do not prescribe a constant value for the total integrated proper energy of an isolated system. For this reason when irreversible processes take place in an isolated system the accompanying increase in entropy is not necessarily subject to the limit imposed in the classical mechanics by a fixed value of the energy, and the possibility arises for isolated systems in which the entropy would continue to increase without ever reaching a maximum value where all change would have to cease.

I have examined this possibility in connection with non-static models of the universe,[18] and have found it possible, if the cosmological constant is zero or negative, to construct conceptual models in which irreversible processes, such as the transformation of matter into radiation under non-equilibrium conditions, would take place, and nevertheless which would show a continued succession of expansions and contractions of increasing amplitude without ever coming to that dreadful final state of quiescence predicted by the classical thermodynamics.

EVALUATION OF THE RESULTS

This completes the description of cosmological models which I had in mind, and we may now ask how far has the theoretical physicist been successful in his three tasks of explanation, of extrapolation and prediction, and of investigation into the conceivable properties that the universe might theoretically have.

In his first task I think that the physicist has been reasonably successful, since he has been able to construct models in accordance with the principles of physics which agree with the findings of the astronomer in at least four ways. They contain a finite density of matter; this matter is uniformly distributed; the gradual transformation of matter into radiation is permitted; and the light from distant objects would show a red-shift approximately proportional to the distance.

As to his second task, that of extrapolation and prediction, I do not think that as yet he has been very successful. He has indeed been able to make one prediction as to a relation that should be found between the apparent diameter, luminosity and red-shift of the nebulae,[19] which can be subjected to observational test. As to the extrapolation of present findings to great distances, however, neither the astronomer nor the physicist can now say whether or not the density of matter and rate of expansion remain approximately the same as has been observed out to 10^8 light years, and we can not yet even tell whether the universe is finite or hyperbolic.[20] *And although* we can completely describe the life history of special models, nevertheless, if we desire to extrapolate in time for the actual universe, we can merely say with some confidence that the process of expansion has lasted for an enormous time in the past and will continue for a very long time in the future.

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[17] Tolman, *Phys. Rev.*, 38, 1758, 1931. Such expansions and contractions also occur in the case of a model previously treated by Einstein (Ref. 14) which was, however, of such a simple mechanical nature as not to suggest the application of thermodynamics.

[18] Tolman, *Phys. Rev.*, 39, 320, 1932.

[19] See Tolman, second article, ref. 14.

In the third task of investigating the conceivable theoretical properties of the universe, there has perhaps been somewhat more success, since the conceivable is subject to less rigorous constraints than the actual. And I think the new thermodynamic possibilities which I have described to you are of considerable interest.

POSSIBLE PHILOSOPHICAL BEARINGS

In conclusion I should like to make a few remarks which may have a certain philosophical bearing.

First, I wish to call your attention to the consideration that although the principles of the physical theory for treating such problems as the one we have described must of course in any case agree with observational facts, these principles are actually suggested to the theoretical physicist in two ways—not only as immediate generalizations of experimental findings, but also as desiderata for the inner harmony and simplicity of the theoretical structure he is attempting to build. We must admire Galileo for insisting on observational fact as the ultimate arbiter, and thus breaking away not from Aristotle but from a decadent Aristotelian tradition. And we must admire him for his power and skill in obtaining physical principles from the immediate generalization of experimental facts. But we must not let this just admiration blind us to the power and skill of those other theoretical physicists who obtain the suggestion for physical principles from the inner workings of the mind and then present their conclusions to the arbitrament of experimental test.

This method of proceeding finds a supreme illustration in Einstein's discovery of the system of relativistic mechanics which we have used in constructing our cosmological models. Einstein did not and could not have based his theory merely on attempts to generalize from the known fact that the orbit of Mercury showed an extremely slight deviation from that predicted by Newtonian mechanics. He built his theory rather on two fundamental principles, the principle of equivalence and the principle of covariance, which suggest themselves on grounds of simplicity, generality and logicality; and the theory so obtained was *then found to contain not only an explanation for* the orbit of Mercury but predictions as well of those other phenomena which have since been verified.

The next matter to which I wish to direct your attention once more is the highly abstract, simplified and idealized nature of the cosmological models that we construct, as compared with the actual universe. This is nothing new in physics, but illustrates a procedure always employed to a greater or less degree in theoretical considerations. It is analogous to the rigid weightless levers of simple mechanics, or the spherical, rigid and perfectly elastic molecules of the simple kinetic theory of gases. The reason for this idealization is obvious. Without such simplifications as are provided, for example, by the assumption of a uniform, homogeneous distribution of matter and radiation throughout our model, the already difficult mathematics would become extremely hard to handle. If, however, we find that our simplified models exhibit such properties as a transformation of matter into radiation and a red-shift in the light from distant objects, we can have a feeling of comfort when we discover these phenomena in the actual universe. And if we discover hitherto unsuspected thermodynamic properties in some of our models, we can at least keep our eyes open for such possibilities in the actual universe.

As a final remark that might have some philosophical interest, I should like to emphasize the special danger in the field of cosmology of the evils of autistic or wish-fulfilling thinking. In studying the problem of cosmology we are immediately aware that the future fate of man is involved in the issue, and we must hence be particularly careful to keep our judgments uninfected by the demands of religion, and unswerved by human hopes and fears. Thus, for example, what appears now to be the mathematical possibility for a highly idealized conceptual cosmological model, which would expand and contract without ever coming to a final state of rest, must not be mistaken for an assertion as to the properties of the actual universe, concerning which we still know all too little. To conclude then: Although I believe it is appropriate to approach the problems of cosmology with feelings of awe for their vastness and of exultation for the temerity of the human spirit in attempting their solution, they must also be approached at the same time with the keen, balanced, critical and skeptical objectivity of the scientist.

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[20] See Heckmann, ref. 14.

OBITUARY

WILSON ALWYN BENTLEY

WILSON ALWYN BENTLEY, member of the American Association for the Advancement of Science and fellow of the American Meteorological Society, was born at Jericho, Vermont, on February 9, 1865. Here he lived the whole of his quiet life, and here died on December 23, 1931. One of his great-grandfathers, Roger Stevens, on his father's side, was a soldier through the Revolutionary War. A great-aunt, Anna Bentley, married Martin Chittenden, twice governor of Vermont. His father, Thomas Edwin Bentley, was an up-to-date farmer for his time and place. His mother, Fannie Eliza Bentley, was a daughter of Moses Coleton, a lumber dealer of Bolton, Vermont. He is survived by a brother, C. F. Bentley, of Andover, Vermont, and certain nephews and nieces. He was of the third generation of Bentleys to live at, or near, Jericho, his grandfather being one of the first settlers of that place.

His boyhood was like that of most New England lads on a small farm, uneventful but wholesome. He attended the local public schools, but acquired no further formal education. Thus far nothing whatever in his life had singled him apart for special mention. Then came, by way of his mother, as so many good things do come, the vision that to the end of his days more and more absorbed his attention, and increasingly made the world his debtor. This was when she showed him the beauty of the snow crystal as seen through a small microscope. He was fascinated and began at once to search every snow that came for the more perfect of its fleeting gems. At first he copied what he saw as best he could with pen or pencil, but this was unsatisfactory. The minute details were difficult to represent, and often melted away before he had had time properly to study and copy them. He therefore soon fixed up a photomicrographic camera which afforded accurate and quicker results. He developed his own technique and acquired a remarkable skill, necessary, of course, in dealing with so delicate and so transient a thing as the tiny snow crystal. He taught music one year, 1885–86, but with that exception his young manhood was spent mainly in labor on the farm. During the last 20 years of his life, however, he lived practically alone (he never married) and gave all his time and attention to his pictures, of which he had several thousand, and to which he added many more every winter.

His first article appeared in 1898. After this he contributed a number of papers on frost and the snow crystal to various publications, and furnished many pictures to authors for use in books and magazines. He also gave an occasional lecture on his hobby, and furnished slides for others to use.

Naturally he dreamed of a great book that should contain many hundreds of his pictures of snow and frost. Artists and others also hoped that some suitable publication might be made of this remarkable collection of pictures which it had taken a devoted lifetime to obtain. The realization of his dream was difficult to effect, but at last it was accomplished. Then, after about three weeks of real happiness, he was joined by the "old man's friend," pneumonia.

Thus the drama ends of the kindly "Snowflake Man" of Jericho, whose thousands of pictures long had been classic, and to whose honored doorstep, however secluded and humble, all the world had worn a path in recognition of true worth.

W. J. HUMPHREYS

MEMORIALS

DR. DENMAN W. ROSS has presented to Harvard University a portrait of the late Theodore W. Richards by Kanji Nakamura, to be placed in the Chemical Laboratory.

THE President's Medal of the National Academy of Design was awarded posthumously to Samuel F. B. Morse, artist and inventor of the telegraph. It was presented on March 28 to his son, William Goodrich Morse, at the Metropolitan Museum of Art, where a special loan exhibition of Morse's paintings was held. The President's Medal has been awarded only once before, Mr. Elihu Root being the recipient.

IN connection with the celebration of the hundredth anniversary of the death of Goethe, *Forschungen und Fortschritte*, Berlin, has published a special number reviewing Goethe's contributions to science, including mathematics, vision, optics, chemistry, geology, meteorology, botany, zoology and anatomy.

A DARWIN exhibition is to be opened at the Communist Academy in Leningrad on April 19, on the fiftieth anniversary of Darwin's death, and a joint meeting of the Communist Academy and the Academy of Sciences is to be held in his honor.

DR. G. CLARIDGE DRUCE, pharmacist and curator of the Fielding Herbarium, Oxford, whose death was reported in SCIENCE last week, has bequeathed his herbarium and library with his house and an endowment for a Botanical Institute at Oxford.

SIR RICHARD WILLIAMS has been appointed president and Professor Gibson treasurer of a fund to purchase for a museum the cottage at Llangerniew, Denbighshire, Wales, where Sir Henry Jones, the philosopher, was born.

RECENT DEATHS

Dr. **Albert Perry Brigham**, professor emeritus of geology at Colgate University, died on April 1, in his seventy-seventh year.

Dean **Francis M. Hartmann**, professor of electrical engineering and dean of the school of engineering of Cooper Union, died on March 28, at the age of sixty-one years.

Mr. **W. W. Ashe**, senior inspector in the Forest Service, died on March 18, as the result of an operation. Mr. Ashe is known for contributions in the field of dendrology, his specialty being the hardwoods of the Southeastern United States. He was the author of numerous publications on forestry and had for many years been active in the development of the acquisition of forest lands by the Federal Government.

Professor **Henry James Priestley**, professor of mathematics and physics in the University of Queensland, died at Brisbane on February 26, at the age of forty-eight years.

The death is announced at the age of fifty-four years of Professor Giuseppe Martinelli, assistant secretary of the Pontifical Academy of Science, Vatican City, and assistant in the Bureau of Meteorology and Geophysics, Rome.

SCIENTIFIC EVENTS

THE MACAULAY INSTITUTE FOR SOIL RESEARCH

According to a statement in the *Experiment Station Record*, this institute was established in Scotland in 1930 through the initiative of Mr. T. B. Macaulay, of Montreal, Canada. Following the purchase and endowment by Mr. Macaulay in 1929 of land for a peat-land demonstration farm on the Island of Lewis in the western Hebrides group, provision was made for the opening of laboratories on the mainland where research connected with Scottish soils in general could be conducted. The institute was accordingly incorporated under a committee of management of eleven members selected by the Department of Agriculture for Scotland and the Scottish agricultural colleges.

A tract of about 50 acres situated at Craigiebuckler on the outskirts of Aberdeen was acquired and equipped with funds contributed by Mr. Macaulay. A large mansion house on the property was fitted up into offices, a library, laboratories and similar purposes. A range of greenhouses was already available, and a cage for pot experiments was constructed in the two-acre walled-in garden. The fields are being laid out into plats to study the effects of lime and different systems of cultivation and manuring, but it is expected that much of the field work of the institute will be carried on in other parts of the country representative of the various soil types.

Funds for the maintenance of the work are at present being provided by the British Development Commission. Close cooperation is being maintained with other institutions in both research and advisory work. The institute has taken over the lysimeter studies of the North of Scotland College of Agriculture at Craibstone, and there have been some curtailments and readjustments at other institutions with a view to the concentration of soil investigations to a large extent at the institute. It is thought that a well-equipped soil institute with an adequate staff will be in a much better position than isolated workers in several different centers to deal with the intricate problems of the very variable soils of Scotland.

In addition to the joint work with the colleges, there will be an increasing amount of collaboration with other research institutions, as in nutrition problems connected with deficiencies in certain soils. The institute is already cooperating with the Scottish Animal Diseases Research Association in questions of malnutrition of mountain sheep and with the Scottish Plant Breeding Station regarding grasses suitable for peat land.

The present staff of the institute consists of a director, Dr. W. G. Ogg; a secretary; a soil geologist; specialists for moorland work, soil surveys and drainage analysis; a technical assistant, and a part-time surveyor and advisory officer who lectures at the West of Scotland College during the winter months. Later it is hoped to add a bacteriologist, an ecologist and an engineer.

THE EDWARD ORTON, JR., CERAMIC FOUNDATION

The Ohio State University Monthly reports that to preserve the enterprise he founded in the interests of the industry to which he gave the best years of his life as a man of science, engineer, teacher and manufacturer, the Edward Orton, Jr., Ceramic Foundation is created by the will of General Edward Orton, Jr., who died on February 10. The will was probated on February 24.

The foundation is established for two purposes: to continue the manufacture and sale of the highest grade pyrometric cones, used in industry, and to use the profits therefrom to advance "the ceramic arts and industries in the United States." Under the will, the estate is divided into two parcels. The first, comprising General Orton's cone manufacturing business, known as the Standard Pyrometric Cone Co., will be used to establish the foundation. The second will consist of the residue of the estate and is left to Mrs. Orton.

The proceeds of a life insurance policy for $10,000 are left to the Ohio State University for the maintenance there of the Edward Orton Memorial Library of Geology, which General Orton had established in memory of his father, the first president of the university, and to which he had annually given $500 for books.

The will sets up a self-perpetuating board of trustees to administer the foundation. It will consist of the following: The president of the Ohio State University, a representative of the U. S. Bureau of Standards, the head of the engineering experiment station of the Ohio State University, the head of the department of Ceramic Engineering of the Ohio State University, the secretary of the American Ceramic Society and one other representative of the society chosen for a three-year term, and an attorney. The trustees will receive $1 a year and expenses. The trustees are to organize within 90 days and take over the cone business and provide for its operation. The will designates Colonel Simeon Nash, General Orton's attorney, as the attorney member of the board.

If for any reason it becomes impossible to continue to operate the business successfully, the trustees are authorized, with approval of the probate court, to close the business and to turn the assets over to the Ohio State University as part of the irreducible debt of the state of Ohio, the income therefrom to be used for ceramic research either through the university's department of ceramic engineering or its experiment station.

The research division of the foundation may be set up as a part of the cone manufacturing establishment or separately, at the discretion of the trustees. In the latter case, the will suggests, it "would be used principally to stimulate and assist research, and to coordinate, supervise and supplement researches undertaken in the ceramic department and engineering experiment station of the Ohio State University, or by other laboratories or groups of laboratories. . . ." In such case also the research director would be authorized to "furnish personnel or loan equipment to laboratories cooperating with him." The will further provides that results of research promoted by the foundation shall be published "to the end that said results shall be given freely to the public and made available for ceramic engineering use."

The board of trustees is directed not to "sell or permit its agents and employees to sell, or to make any charge, direct or indirect, for any information furnished through or by said research department, to the end that all surplus over and above the cost of production made upon the sale of Standard Pyrometric Cones shall be returned to the ceramic industries in the form of technical knowledge."

The will further provides that, since the estate is "severely depleted" because of the creation of the trust and there has thus been taken from it "its chief income producing element," for five years there shall be paid to Mrs. Orton specified sums from current earnings of the cone business. Mrs. Orton and Colonel Nash were named coexecutors of the will, which requested that they be not required to furnish bond.

MARINE EXPEDITION TO THE WEST INDIES

THE International Expedition to the West Indies completed its work at Miami on March 19. The major results of the expedition include 4,000 miles of sonic sounding and 64 gravity stations at sea and on the island. The maximum depth registered in the Bartlett Trough was 4,000 fathoms, which is supposed to be 400 fathoms deeper than shown on any previous soundings. Twenty-nine of the gravity stations at sea have already been computed and, while it is perhaps too early to make a definite statement as to the major structural characteristics of the West Indian region and especially of the Bahamas, it would appear as if the Bahama region as a whole was acting as a single block of the earth's crust and that this block has undergone vertical movements of the first order.

The determination of gravity on the islands has been under the direction of Lieutenant Joseph P. Lushene, who operated from the yacht *Marmion*, loaned and navigated by Mr. Hugh Matheson, of Miami. Owing to the skill of Mr. Matheson and Lieutenant Lushene, this unit of the expedition succeeded in making 12 gravity stations in approximately 30 days.

The council and personnel of the expedition are deeply indebted to the U. S. Navy, and especially to the personnel of the submarine S-48 and the rescue vessel *Chewink* for their interest and extreme helpfulness in carrying out the program of sonic sounding and determination of gravity at sea. Dr. F. A. Vening Meinesz, who was in charge of the most important part of the program, was assisted by a representative of the Naval Laboratories and Mr. Harry Hess, Procter fellow of geology at Princeton University. Dr. Meinesz and Mr. Hess are at present of the opinion that, while the Bartlett Trough is, as has already been supposed, largely a structural feature and at present probably the main zone of weakness in the region, the relatively deep areas of the sea, such as Exuma Sound, the Tongue of the Ocean and Providence Channel, suggest the possibility of being drowned river valleys. It will probably be two or three months before the gravity stations and isostatic deductions have all been computed, and it is hoped that the geological significance of the expedition can be reported at that time.

Richard M. Field

Princeton University

THE PULLMAN MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION

A preliminary announcement of the Pullman meeting has just been distributed to members of the American Association for the Advancement of Science resident in British Columbia, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah and Washington.

Two of the principal addresses to be presented during the meeting will be given by Professor A. O. Leuschner, president of the Pacific Division, and Professor J Harlen Bretz, of the University of Chicago. The subject of Professor Leuschner's address will be "The Astronomical Romance of Pluto." The events that led to the discovery of Pluto, the investigations on its orbit and mass and the question of its nature as a celestial object will be discussed. Professor Bretz's address, which will be on "The Scablands of the Columbia Plateau in Washington," is of special interest in view of a general symposium to be held on "Scientific Problems of the Columbia Plateau."

Under this heading, four topics will be introduced for discussion in the session of Thursday morning, June 16:

Interesting Botanical Areas, Dr. F. L. Pickett, professor of botany, the State College of Washington.

Geological Problems, Mr. M. G. Hoffman, assistant professor of petrology, the State College of Washington.

Economic and Agricultural Problems of the Wheat and Apple Industries, Dr. E. F. Dummeier, professor of economics, the State College of Washington.

Engineering Problems, Dean Ivan C. Crawford, dean of the College of Engineering, the University of Idaho.

In accordance with the custom of recent years, the opening session on Wednesday, June 15, will be devoted to research reviews. The purpose of these is to survey the progress of scientific research on the Pacific Coast and in the Far West, the subjects under investigation being reviewed in the light of their relation to problems of major interest in the sciences at large. Attention will be centered upon a few of the most noteworthy accomplishments in each field. The reviews will be presented as follows:

Astronomy and Astrophysics: Dr. J. S. Plaskett, Dominion Observatory, Victoria, B. C.

Chemistry: Dr. J. B. Ramsey, University of California at Los Angeles.

Physics: Dr. W. V. Houston, California Institute of Technology.

Animal Sciences: Dr. J. E. Guberlet, University of Washington.

Plant Sciences: Professor G. J. Peirce, Stanford University.

The greater part of Thursday and Friday will be given over to the programs of the participating societies. Members proposing to present papers are reminded that titles received later than May 2 can not be published in the association program.

A visit to the University of Idaho, and excursions to Kamiak Butte, Almota Canyon, Moscow Mountain, Bald Butte, Snake River Canyon, Wallowa Mountains and the Scablands are under arrangement. Areas of considerable interest to the biologist and geologist will be visited.

SCIENTIFIC NOTES AND NEWS

The honorary doctorate of laws was conferred on March 23 by the University of California on Dr. William Wallace Campbell, formerly director of Lick Observatory and from 1923 to 1930 president of the university.

Dr. Graham Lusk, professor of physiology in the Cornell Medical College, was recently elected a corresponding member of the Prussian Academy of Sciences.

Dr. Charles B. Davenport, director of the Station for Experimental Evolution of the Carnegie Institution of Washington, has been elected a member of the German Academy of Sciences at Halle.

The Priestley Medal of the American Chemical Society has been awarded to Dr. Charles L. Parsons, since 1907 secretary of the society.

The prize of $1,000 of the American Chemical Society, founded in 1931 by Dr. A. C. Langmuir, has been awarded to Dr. Oscar K. Rice, instructor in chemistry at Harvard University. The prize is awarded to the most promising chemist in North America, less than thirty years old, in recognition of outstanding research in pure chemistry. Dr. Linus Pauling, of the California Institute of Technology, received the award last year.

At the annual meeting of the Physical Society, London, on March 18, the Duddell Medal was presented to Professor C. T. R. Wilson, F.R.S.

Dr. Edwin Stephen Goodrich, Linacre professor of zoology and comparative anatomy, University of Oxford, has been selected by the council of the Linnean Society of London as the recipient of the Linnean Medal, which will be presented to him at the anniversary meeting on May 24.

The Meldola Medal, the gift of the Society of Maccabaeans, was presented on March 1 to Dr. G. F. Marrian, of University College, London, in recognition of his researches on vitamins and hormones, at the fifty-fourth annual general meeting of the British Institute of Chemistry.

In recognition of his services to Queen's University, Belfast, where he had been professor of surgery for thirty-seven years, Dr. Thomas Sinclair was recently presented with a portrait of himself by Mr. George Harcourt. Viscount Bangor, who presided, referred to Professor Sinclair's career in the army, the Imperial Parliament and the Senate of Northern Ireland. Sir Thomas Houston spoke particularly of the debt that the Belfast school and his former pupils owed to Dr. Sinclair.

A portrait of Dr. J. Parsons Schaeffer, professor of anatomy at the Jefferson Medical College and director of the Daniel Baugh Institute of Anatomy, was presented to the college on March 15 by the graduating class. The portrait was painted by Lazar Raditz, of Philadelphia.

For outstanding contributions to progress in the medical science, Dr. Elliott Proctor Joslin, of the Harvard Medical School, and Dr. Aleš Hrdlička, of the Smithsonian Institution, have been awarded the 1932 honors of the Kober Foundation, Georgetown University. Dr. Joslin, authority on diabetes mellitus, will receive the foundation's medal at the meeting in Atlantic City of the Association of American Physicians on May 3. Dr. Hrdlička, curator of physical anthropology at the Smithsonian Institution, has been designated foundation lecturer for this year.

Dr. George R. La Rue, professor of zoology at the University of Michigan and director of the Biological Camp at Douglas Lake, was elected president of the Michigan Academy of Science, Arts and Letters at the conclusion of the annual meeting at Ann Arbor. Mr. Robert B. Newcomb, of the State Department of Conservation, was elected vice-president.

Sir William J. Pope, professor of chemistry in the University of Cambridge, has been elected chairman of the Council of the City and Guilds of London Institute in succession to the late Dr. Morton Latham.

Lord Moynihan of Leeds has been elected a member of the committee of the Radium Institute, London, in the place of Sir Hugh M. Rigby, who has resigned on his retirement from practice and removal from London.

The committee on scientific research of the American Medical Association has made a grant to Professor Arthur H. Smith, of the laboratory of physiological chemistry, Yale University, for the continuation of his studies on the blood of animals subjected to restriction of inorganic salts in the diet.

Dr. Max W. Gardner, chief in botany in the Indiana Experiment Station, has been appointed professor of plant pathology and plant pathologist at the University of California and the California Experiment Station.

Dr. Herbert E. Roaf, professor of physiology in the London Hospital Medical College, has accepted an offer of appointment to the George Holt chair of physiology at the University of Liverpool, in place of Professor J. S. Macdonald, who will retire at the end of the present session.

At a general meeting of the governing body of Magdalen College, Oxford, Mr. Eric Balliol Moullin, university reader in engineering science, was elected to a fellowship.

Dr. Oskar Seifried has sailed for Germany, having accepted the professorship of general pathology and pathological anatomy in the veterinary faculty of the University of Munich, succeeding Professor T. Kitt. Dr. Seifried was associate and later associate member in the department of animal and plant pathology of the Rockefeller Institute for Medical Research at Princeton, N. J.

The Reverend Emmanuel M. Sanchez-Navarro Neumann, S.J., who has been in charge of the observatory at Cartuja, near Granada, Spain, and who is known for his researches in the field of seismology, was expelled from his observatory by the new Spanish government on February 2. He is now an exile in Naples, Italy. He was obliged to leave behind the accumulation of twenty-five years of labor with his instruments and books.

Dr. W. A. Shewhart, of the Bell Telephone Laboratories, will sail on April 9 for a two months' trip to Europe. His first engagement will be the delivery of three lectures at the University of London on the rôle of statistical method in industrial standardization. A number of conferences in theoretical and applied statistics with Dr. Shewhart have been arranged both in Great Britain and on the continent.

Professor Herbert Osborn, of the Ohio State University, has returned to Columbus from a winter vacation in Florida and will resume his work for the spring quarter. At the scientific meetings at New Orleans he was the guest of honor at the annual Entomologists dinner. Dr. Osborn addressed the Southern Beekeepers Conference at St. Petersburg, Florida, on February 3 and the zoology students at Rollins College on March 11.

Dr. Arthur J. Tieje, chairman of the department of geology at the University of Southern California, will again give the courses in geology at the summer session of Columbia University. He will drive to New York, with the aim of adding to his collection of rock suites representing the historical geology of the states. Later he will spend a month abroad, collecting European rocks.

Mr. Gerrit S. Miller, Jr., curator of the division of mammals of the U. S. National Museum, is spending two months in Porto Rico, exploring caves for remains of extinct animal bones.

A seven-weeks course of daily lectures and discussions on the principles and methods of hydrology as pertaining to the ground waters was given at the U. S. Geological Survey from February 1 to March 19. The discussions were led by Dr. O. E. Meinzer, Mr. W. D. Collins, Mr. D. G. Thompson, Mr. W. N. White, Mr. A. G. Fiedler and other members of the staff.

Dr. Arthur H. Compton, of the University of Chicago, gave four addresses at the University of Oklahoma, on March 19 and 20. He spoke before the department of physics on "Cosmic Rays and Atomic Nuclei" and "New Experiments on the Structure of the Atom," and before a general university convocation on "Are Man's Actions Determined by Physical Laws?" He was also the principal speaker at the annual banquet of the college of engineering, and was the guest of honor at a department of physics luncheon.

Lectures will be given in the Mallinckrodt Laboratory, Harvard University, as follows: April 11, at 8 P. M., Dr. N. V. Sidgwick, fellow of Lincoln College, Oxford, on "The Structure of Simple Molecules"; April 14, at 4:30 P. M., Professor Peter Debye, of the University of Leipzig, on "The Interionic Attraction Theory of Electrolytes."

Dr. B. A. Keen, assistant director of the Rothamsted Experimental Station, delivered the G. J. Symons memorial lecture before the Royal Meteorological Society, on March 16. The subject of Dr. Keen's lecture was "Soil Physics in Relation to Meteorology."

A lecture under the auspices of the Smithsonian Institution was given at the U. S. National Museum on March 30 on "Plant Records of the Rocks" by Dr. Albert Charles Seward, master of Downing College and professor of botany at the University of Cambridge. During his stay in the United States Professor Seward expects to lecture in Boston, Washington, Chicago, San Francisco and Seattle.

Sir Frank Dyson, Astronomer Royal of Great Britain, will be a member of an expedition that will visit the United States and Canada to observe the total solar eclipse on August 31. Sir Frank will preside at the meeting of the International Astronomical Union which meets at the Harvard College Observatory. Other members of the party will be Dr. Harold Knox-Shaw, president of the Royal Astronomical Society; Sir A. S. Eddington, Plumian professor of astronomy at the University of Cambridge, Lord Raleigh, and Dr. L. J. Comrie, of the Royal Naval College, Greenwich, superintendent of the British Nautical Almanac office.

The fourteenth annual meeting of the American Society of Mammalogists will be held in Washington from May 3 to 7, the sessions for the presentation of papers, discussion and business to convene at the National Museum. The local committee on arrangements consists of Dr. W. M. Mann, director of the National Zoological Park; Dr. Remington Kellogg, assistant curator of the division of mammals; Ernest P. Walker, assistant director of the National Zoological Park, and Mr. Walter C. Henderson and Dr. H. H. T. Jackson, of the Bureau of Biological Survey. According to the plans of this committee, a combined reception, smoker and movies will be held on Wednesday evening, May 4, and the annual dinner on Thursday evening, May 5. On Saturday there will be a luncheon at the National Zoological Park, with a tour of the park in the afternoon.

The Association of American Medical Colleges announces the completion of the third annual study of the accomplishment of students during their first year in medical school. This study includes the class of 1930, numbering 6,315 students, who came from 584 colleges of liberal arts. The record shows how many students made a clear record, how many had an encumbered record and how many failed completely. The name of the student and the medical college attended completes the record. The subjects in which conditions or failures, or both, were made are also carded. Colleges of liberal arts who sent students into medicine in the fall of 1930 may obtain a complete record of the accomplishment of these students by writing to the secretary of the association, Dr. Fred C. Zapffe, 25 East Washington Street, Chicago.

Museum News reports that McGill University, Montreal, will give its summer course in medical museum technique this year from June 13 to 25.

Only eight students will be admitted, and registration for the course will close on April 30. Lectures and demonstrations will be held in the recently built Pathological Institute of the university and students will have an opportunity to examine an extensive and representative collection of museum specimens, including pathological, osteological, anatomical and zoological material. The two weeks course will be devoted to laboratory layout, equipment, lighting, etc., glass frame technique, color preservation, museum jars, mounting of specimens, corrosion and injection, cleaning of bones, osteological preparation, cross sections, clock glass and petri dish mounting, dry mounting, gelatine, cement, records, storage and case exhibits. Students will be given an opportunity of spending an extra week in the laboratory. Inquiries should be addressed to Mr. E. L. Judah, curator of Museums, McGill University, 3755 University Street, Montreal.

AMONG the exhibits displayed on March 9 at a scientific reunion held in the board room of the British Museum of Natural History at South Kensington were, according to the London *Times,* a number of fossil fauna recovered from the site at Oldoway in Tanganyika by Mr. A. T. Hopwood, of the museum staff. The significance of the Oldoway discoveries was discussed by Mr. L. S. B. Leakey, in an article in the issue of the *Times* for March 9, and the exhibits shown at South Kensington included remains of a number of Pleistocene mammals, among them several teeth of the Dinotherium, an aberrant sideline from the family of the elephant. Hitherto this animal has been associated with the Miocene period, but it was found in the Oldoway beds with remains of the elephant itself. A fossilized elephant tooth from this deposit was exhibited yesterday for comparison, together with the mandible and palate of the *Elephas antiquus recki* found in the lowest bed, and associated by European analogies with the Middle Pleistocene period. From this lowest bed and that immediately above it there were exhibited two antelope skulls of a new type and a kudu skull complete with horns. The zoological exhibits included species of the Siphonophora, a very primitive type of animal in which evolution has not yet reached the stage of producing a body cavity; the specimens displayed included tropical, Arctic and Antarctic variations of its sac-like constitution. A new genus of scorpion collected by Mr. Bertram Thomas in Arabia attracted much attention, not merely by its unprecedentedly flattened tail, but through the occasional existence of a tibial spine such as was found in its relatives of the Silurian period and the oldest surviving genus of scorpions to-day, but not in the more recent genera. The department of botany showed specimens of the "Fungus Stone" or "Rock Mushroom," a hard mass of fungal mycelium and earth which, when watered, produces an edible fungus, causing much astonishment to naturalists from the time of Strabo to that of Pepys.

DISCUSSION

BIOLOGICAL ABSTRACTS AND THE COLLEGE

THE question of the advisability of continuing and improving *Biological Abstracts* again arises, now that we have five years' actual experience with the usefulness of the journal. To be sure it is regrettable that the *Abstracts* are not as up to date as might be wished, nor as yet completely indexed, but the undertaking is well launched, and we have the word of the editor, who said at the New Orleans meetings that it needs only a somewhat greater support to improve in those ways where they are now found wanting. In a recent issue of SCIENCE, Dr. Lillie pointed out the unique character of the publication, the fact that in its comprehensiveness (and withal, compactness) there is an immense saving in dollars to biologists, who, to get a similar service otherwise, would have to subscribe to many abstract journals, each only partially covering the field. There seems to be no question of the value of the *Abstracts* to biological research, nor of the value to society, in turn, of that research.

It must be remembered that the *Abstracts* play a part of varying significance in the work of biologists in different types of institutions, and it is the use made of the publication by those of us connected with small colleges which I wish to emphasize. The library appropriations in the colleges are uniformly smaller than those of the universities; any large number of the important journals in the field of biology is therefore quite out of the question for college budgets. Thus every aid in giving to the colleges as wide a survey as possible of what is being done in research is to be commended. *Biological Abstracts* gives such a survey in brief and gives likewise access to the material that can then be temporarily borrowed from the larger loan libraries which so generously provide service of this type. Students in my own college, for example, use *Biological Abstracts* extensively in the preparation of seminar reports and in small research problems. Further, all teachers in small institutions will agree that the *Abstracts* are invaluable aids to teaching, in keeping abreast of the times in fields in which they do not regularly receive reprints from their colleagues.

Is the situation in the colleges to be considered significant or critical, when admittedly the greatest volume of published research in the biological sciences comes out of the universities? It can be shown, I think, that it is of vital importance. A glance at the "American Men of Science" will show that the American scientists have begun their education in two sorts of institutions, roughly classifiable into small colleges and large universities. A count shows the proportion starting in the smaller schools to be about two for every three starting in the larger ones. But a survey of the total enrolment of students found in those of the two types of schools listed in the above publication shows about four times as many for the larger institutions as for the smaller. (In the *New York Times* of November 16, last year, a list shows approximately as many students in some 600 small colleges as in the larger universities. One can conclude that not all the small colleges have contributed to the "American Men of Science.") Thus, upon consideration of the institutions which any contribution at all to make to productivity as noted in the "American Men of Science," it appears that any given college undergraduate has two and two thirds greater chance of ultimate productivity than any given university undergraduate. Furthermore, the readers of SCIENCE can think of their own early training, and that of their colleagues, to see where a large proportion of them got their first start. An analysis, too, of the present graduate students of promise in any of the universities would indicate a large number coming previously from small colleges. Obviously, if they started in a small college, it must have been there that their interest was stimulated along their chosen line before they sought advanced study in the larger university. Unless we would kill the goose that laid the golden egg, we must not overlook the small schools, even though they be relatively unproductive of important finished research. Let our colleagues in the universities with access to the complete files of the chief journals remember the close relation existing between the colleges and the graduate schools, and help us in feeding to them the student with the inquiring mind.

To take the place of the commercial and industrial concerns standing back of the *Abstracts* of our colleagues, the chemists, we shall probably have to depend always on some sort of philanthropic support outside our circle of scientific investigators and teachers. This is the more true since the number of articles to be abstracted greatly exceeds that in the field of chemistry, and this is a correspondingly greater undertaking. But a united front on the part of the biologists of the country in fully approving the continuance and the continued improvement of *Biological Abstracts*, and their tangible support of the undertaking by subscriptions, will do much. In that direction an unmistakable evidence of support has already been indicated in the well-known fact that the publication in question has more subscribers than any other technical biological journal.

HOPE HIBBARD

OBERLIN COLLEGE

THALLIUM POISONING

DR. BROOKS' recent note in SCIENCE for January 22, 1932, page 105, is unusually interesting. Until about a year ago, I was scarcely aware that such a toxic element as thallium existed. In the *Journal of the American Medical Association,* May 30, 1931, pages 1866–1868, appeared three different articles on the toxic effects of thallium, as used in a cosmetic preparation for removing hair. In the same journal for September 19, 1931, page 851, appeared an account of two fatal cases of thallium poisoning, due to the administration of the acetate as a depilatory in scalp ringworm. The same journal contains various other notes on the toxicity of the element. On January 30, of this year, page 406, is an editorial comment on fatal human cases due to eating poisoned grain. In the issue of February 20, 1932, pages 618–620, is a very complete note on thallium poisoning from a depilatory cream. A discussion of the element, from its discovery to its dangerous therapeutic use and toxic properties, is given. Its toxicity and pathologic effects on higher animals appear to be well known.

It is quite a surprise to learn that it seems to be equally toxic for vegetation. The amount of thallium distributed in poisoned grain for destroying rodents and other forms of life is quite appalling. In its use in destroying ground squirrels, it would be interesting to know if there is any likelihood of the thallium treated grain being placed in the same situation year after year. That is, are the old burrows occupied by incoming ground squirrels? If such is the case, there would seem to be danger of causing patches of soil sterility. All in all, thallium apparently is a dangerous poison, and it would be well to restrict its use in human medicine and wholesale poisoning activities for lower forms of life, until more is known about its action and the habits of the animals against which it is used.

It is interesting to note that the *Journal of the American Medical Association* for February 27, 1932, page 741, contains a news item that the poisonous depilatory cream has been prohibited for sale in San

Francisco. However, the State Department of Agriculture of California (Serial Publication No. 109) uses thousands of pounds of thallium coated grain in rodent control work. In spite of careful supervision, several fatal cases[1] of thallium poisoning in man have already occurred, as well as some losses to domestic animals, according to press dispatches.

MARCUS WARD LYON, JR.
SOUTH BEND, INDIANA

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[1] A preliminary report of these cases appears in the *Journal of the American Medical Association* for March 26, 1932, page 1076.

THE EXISTENCE OF AN EXTRA-PANCREATIC (OR CELLULAR) INSULIN IN THE DOG AFTER PANCREATECTOMY?

A RECENT article by Tuttle[1] offers a reinterpretation of some results published by the present writer in the paper entitled "The Utilization of Carbohydrate by Totally Depancreatized Dogs Receiving no Insulin."[2] While granting that the results in question undoubtedly show the utilization of large amounts of carbohydrate by such animals, Tuttle interprets this as being evidence for "the existence of an extra-pancreatic (or cellular) insulin in the dog after pancreatectomy."

I should like to point out that this hypothesis was considered in my paper, but rejected in favor of the "Overproduction Theory of Diabetes," for the following reasons:

(1) The animals did not survive indefinitely, as they do with insulin injections. Nor can the death of these animals be ascribed to the withdrawal of raw pancreas from their diet, as Tuttle suggests. Reference to a later paper by Hershey and the writer[3] will readily show the difference in the time periods involved and the entirely different pictures presented by these two syndromes.

(2) Dogs 1 and 14 (Tables I and IX), which according to the results obtained should have acquired a fairly adequate extra-pancreatic insulin supply, were as "diabetic" as ever when insulin injections were resumed and then discontinued for the second time.

But perhaps a greater objection to Tuttle's contentions is based upon what the writer believes to be a fundamental error in the logic employed. Tuttle's major premise is that "insulin is necessary for the oxidation of glucose." It must be pointed out, however, that this belief is largely based upon the supposedly fixed and peculiar nature of the D:N ratio and the respiratory quotient in the diabetic organism. Since the validity of these phenomena is the very thing which my results have disproven, Tuttle has, in effect, assumed as true the very thing he set out to prove.

SAMUEL SOSKIN
MICHAEL REESE HOSPITAL,
CHICAGO, ILLINOIS

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[1] *New Eng. Jour. Med.*, 206: 8, Jan. 7, 1932.

[2] *Jour. of Nutrition*, iii: 99, Sept., 1930.

[3] *Am. Jour. of Physiol.*, 98: 74, Aug., 1931.

THE MUSKRAT, A NEW HOST FOR PARAGONIMUS

DR. E. W. PRICE[1] has recently described four new species of trematodes from the muskrat, *Ondatra zibethica*, and in the same paper included a key to all the known trematodes of this animal, but the mammalian lung fluke, *Paragonimus*, was not listed. I pointed out in a recent paper[2] that I had been able to infect muskrats with *Paragonimus* in the laboratory, but that I had not found this parasite in a collection of 249 wild muskrats from Michigan, chiefly from the southeastern part of the state. Since that paper appeared, this parasite has been found in wild muskrats from two localities in western Michigan. During November, 1931, four out of 34 muskrat carcasses secured near Manistee for the use of the class in parasitology were found to be infected with *Paragonimus*. Later, two out of 19 carcasses from the same source and four out of 26 from Muskegon examined by me were infected. Three of them bore unusually heavy infections. Thus, during the fall of 1931, 79 muskrats were examined, of which 10 (12 per cent.) were infected.

In the same paper indicated above, I expressed an opinion that the mink is the normal definitive host of *Paragonimus* since a 17 per cent. infection was found in a collection of 563 carcasses of minks from Michigan and northern Ohio. *Paragonimus* was not found in 308 raccoons, 109 opossums, 22 weasels and one badger from the same region examined during the same period. Wallace[3] reported a 7 per cent. infection in 234 minks which he examined at fur farms in Minnesota.

The discovery of *Paragonimus* in such a high percentage of wild muskrats from a limited locality warrants the assumption that, under certain conditions, these animals serve as well as the mink in the capacity of definitive host.

DONALD J. AMEEL
DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF MICHIGAN

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[1] E. W. Price, "Four New Species of Trematode Worms from the Muskrat, *Ondatra zibethica*, with a Key to the Trematode Parasites of the Muskrat," Proc. U. S. Nat. Mus., 79: art. 4, 1–13, 1931.

[2] D. J. Ameel, "More Data on the Lung Fluke, Paragonimus, in North America," SCIENCE, n. s., 74: 493–494, 1931.

[3] F. G. Wallace, "Lung Flukes of the Genus Paragonimus in American Mink," *Jour. Am. Vet. Med. Asso.*, 81: 225–234, 1931.

CONICAL SNOW

The writer has read with much interest recent articles in Science, treating of conical snowflakes. Every late autumn and early spring there occurs at Jericho, in northern Vermont, and of course at other similar localities, several falls of such snow, and also an occasional one in winter. It comes only out of cumulo-nimbus clouds, and more commonly when the surface temperature ranges from 34° to 44° F. Conical snowflakes have a granular texture and are built up mainly from countless undercooled cloud droplets that have frozen loosely together. Their greatest diameter ranges from one sixth to one third inch. The writer assumes, from a longtime study of this form of snow, that the nuclei usually, if not invariably, consist of branching tabular crystals.

It is of much interest to consider the conditions within a cumulus cloud that conspire to make the undercooled droplets so arrange themselves upon a tabular snow crystal as to form a granular snow cone. It is certain that, owing to its lightness, a tabular branching snow crystal within a cumulonimbus cloud is first wafted upward and about by turbulent air currents. This causes it to become thickly coated on both sides with frozen cloud droplets or granular snow. It now begins to fall with the denser side turned downward, and since it falls faster than the cloud droplets, light granular material then rapidly collects on (is caught by) the under face, thereby destroying the former gravitational equilibrium of the mass and causing it to upset, whereupon the granular snow is caught exclusively, or nearly so, by the new underside, and thus the whole converted into a more or less well-defined double cone with its abutting bases on the opposite sides of the initial tabular crystal. It is conceivable, given a cumulo-nimbus cloud of sufficient thickness, that additional upsettings might occur and thus cause the double cone to become more nearly symmetrical about its basal plane than it otherwise would be.

Wilson A. Bentley[1]

Jericho, Vermont

RELATIONS BETWEEN FUNDAMENTAL PHYSICAL CONSTANTS

In an article with the above title, J. E. Mills[1] gives a number of numerical coincidences, such as $(2\pi c) m_0^6 = 10^{-131}$, $(2\pi c) h^{3/2} = 10^{-28}$, $(2\pi c) e^{6/7} = 10^{23/7}$, where c = velocity of light, m_0 = mass of electron, h = Planck's constant, e = electronic charge. Since the numerical values of the constants that he quotes are those suggested by me in 1929[2] I may perhaps be permitted a few words on the subject.

It seems necessary, from time to time, to call attention to the fact that the *numerical* value of any constant, or combination of constants, is entirely arbitrary if the constant, or combination, possesses dimensions. The value in such cases depends directly upon the unit adopted for each dimension. Mills uses values in the C. G. S. system, and these values accordingly depend upon the arbitrarily chosen units of length, mass and time—the cm. gram and second. It is almost inconceivable that there should be an accidental theoretically significant relation between these three units, whose origin is too well known to restate. All the combinations of constants given by Mills have dimensions, and all are equated to 10^n, where n is an integer or fraction.

It is only in the case of dimensionless combinations that the numerical value can have theoretical significance. The two most famous combinations of this character are the fine structure constant α $(= 2\pi e^2/hc)$ and the ratio of the mass of the proton to that of the electron. There are in the literature several articles discussing the possible theoretical significance of these two pure numbers (approximately 1/137 and 1840, respectively). As a much more striking example of the type of numerical coincidence found by Mills, one may quote the known values, mass of electron $= 9.035 \times 10^{-28}$ gram, angular momentum (spin) of electron $= 9.02 \times 10^{-28}$ erg. sec (see, for instance, Pauling and Goudsmit, "Structure of Line Spectra" page 54). But one can not equate grams to erg. sec any more than one can equate horses to oranges—to use a homely but correct analogy.

Raymond T. Birge

University of California,
March 2, 1932

SPECIAL CORRESPONDENCE

THE PHILADELPHIA INSTITUTE FOR MEDICAL RESEARCH

Medical service is about to receive an important addition through the creation of the Philadelphia Institute for Medical Research. The institute will begin its work next fall. Dr. Leonard G. Rowntree, now director of clinical investigation of the Mayo Clinic, Rochester, Minnesota, and professor of medicine in the University of Minnesota, has been appointed director.

This institute will center its activities in the great Philadelphia General Hospital. Here, in so far as medical research is concerned, it will afford a common meeting place for all medical school services centered in the Philadelphia General Hospital. In addition, however, the new institute will hold itself ready to cooperate, aid and foster medical research by collaboration or affiliation with any or all medical and allied institutions desirous of establishing such a relationship.

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[1] An obituary note of Mr. Bentley will be found in the present issue of Science.

[1] Science, 75: 243, Feb. 26, 1932.

[2] *Physical Review Supplement*, 1, 1, 1929.

Why, one may ask, is so much emphasis placed upon the need for medical investigation? Because experience has shown that progress in the past has come largely through this channel and because it is realized that investigation is essential for the better understanding of disease, its prevention and cure and for the better care of the sick. These various considerations constitute the sole object of the Philadelphia Institute for Medical Research.

Research in medicine in the past has come largely through contributions from universities, medical schools, their hospitals and clinics. More recently, because of urgent need, special institutions of research have been created in certain of the great cities in Europe and this country, the best known being the Pasteur Institute in Paris, the Rockefeller Institute for Medical Research in New York City, and one of quite recent date, the Thorndike Laboratory in the Boston City Hospital. All these institutes have made tremendous and permanent contributions to medicine, and added much to the welfare of mankind.

The Philadelphia Institute for Medical Research will occupy a somewhat analogous position to the Thorndike Institute and will concern itself with what is termed clinical investigation, *viz.*, the study of the sick and the diseases from which they suffer. Research will be made for methods of value for the prevention of disease, for improvements in methods of its study, and of diagnosis and treatment of disease, more especially in the earlier stages. Research will be prosecuted also in the fundamental branches of science underlying medical knowledge.

A pioneer feature of this new institute is the attempt to center and foster research through affiliation and collaboration with all medical institutions in Philadelphia, centering its efforts in the Philadelphia General Hospital.

In 1922 a group of Philadelphia physicians, realizing the supreme importance to humanity of research in medicine, arranged a centenary celebration of the birth of Pasteur, which led to the foundation of the Philadelphia Institute for Medical Research, the charter members of which were: Dr. William Duffield Robinson, Admiral William C. Braisted, Dr. Judson Daland, Dr. Frances X. Dercum, Dr. McCluney Radcliffe, Provost Edgar Fahs Smith, Dr. Charles A. E. Codman, Hon. Hampton L. Carson, Joseph Carson, Esq.

In establishing an institution of this kind, it is of the utmost importance to find a man to act as director, possessing the necessary knowledge, enthusiasm, training and proven ability to lead, in all questions concerning medical research. Such a man was found in the senior medical consultant and director of clinical investigation of the Mayo Clinic, Rochester, Minnesota, Dr. Leonard G. Rowntree, who will assume the duties of director at the opening of the institute in the fall of this year.

Plans are under way for the organization of the personnel of the institute.

A site, on the grounds of the Philadelphia General Hospital, has been assigned by the city council for the erection of a new building, at such time as funds become available. In the beginning, however, the institute will occupy temporary quarters in a new building now under construction, at the Philadelphia General Hospital, and will function in conjunction with the staffs of that hospital.

JUDSON DALAND,
President

PHILADELPHIA

QUOTATIONS

ON THE RELATION BETWEEN THE EXPANSION AND THE MEAN DENSITY OF THE UNIVERSE[1]

IN a recent note in the *Göttinger Nachrichten,* Dr. O. Heckmann has pointed out that the non-static solutions of the field equations of the general theory of relativity with constant density do not necessarily imply a positive curvature of three-dimensional space, but that this curvature may also be negative or zero.

There is no direct observational evidence for the curvature, the only directly observed data being the mean density and the expansion, which latter proves that the actual universe corresponds to the non-statical case. It is therefore clear that from the direct data of observation we can derive neither the sign nor the value of the curvature, and the question arises whether it is possible to represent the observed facts without introducing a curvature at all.

Historically the term containing the "cosmological constant" λ was introduced into the field equations in order to enable us to account theoretically for the existence of a finite mean density in a static universe.

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[1] Article by Professors A. Einstein and W. de Sitter in the *Proceedings* of the National Academy of Sciences for March. Communicated by the Mount Wilson Observatory, January 25, 1932.

It now appears that in the dynamical case this end can be reached without the introduction of λ.

If we suppose the curvature to be zero, the line-element is

$$ds^2 = -R^2(dx^2 + dy^2 + dz^2) + c^2dt^2, \qquad (1)$$

where R is a function of t only, and c is the velocity of light. If, for the sake of simplicity, we neglect the pressure p,[2] the field equations without λ lead to two differential equations, of which we need only one, which in the case of zero curvature reduces to:

$$\frac{1}{R^2}\left(\frac{dR}{cdt}\right)^2 = \frac{1}{3}\kappa\rho. \qquad (2)$$

The observations give the coefficient of expansion and the mean density:

$$\frac{1}{R}\,\frac{dR}{cdt} = h = \frac{1}{R_B};\ \rho = \frac{2}{\kappa R^2_A}.$$

Therefore we have, from (2), the theoretical relation

$$h^2 = \frac{1}{3}\kappa\rho \qquad (3)$$

or

$$\frac{R^2_A}{R^2_B} = \frac{2}{3} \qquad (3')$$

Taking for the coefficient of expansion

$$h = 500 \text{ km./sec. per } 10^6 \text{ parsecs}, \qquad (4)$$

or

$$R_B = 2 \times 10^{27} \text{ cm.},$$

we find

$$R_A = 1.63 \times 10^{27} \text{ cm.},$$

or

$$\rho = 4 \times 10^{-28} \text{ gr. cm.}^{-3}, \qquad (5)$$

which happens to coincide exactly with the upper limit for the density adopted by one of us.[3]

The determination of the coefficient of expansion h depends on the measured red-shifts, which do not introduce any appreciable uncertainty, and the distances of the extra-galactic nebulae, which are still very uncertain. The density depends on the assumed masses of these nebulae and on the scale of distance, and involves, moreover, the assumption that all the material mass in the universe is concentrated in the nebulae. It does not seem probable that this latter assumption will introduce any appreciable factor of uncertainty. Admitting it, the ratio h^2/ρ, or R^2_A/R^2_B, as derived from observations, becomes proportional to Δ/M, Δ being the side of a cube containing on the average one nebula, and M the average mass of the nebulae. The values adopted above would correspond to $\Delta = 10^6$ light years, $M = 2.10^{11}\odot$, which is about Dr. Oort's estimate of the mass of our own galactic system. Although, therefore, the density (5) corresponding to the assumption of zero curvature and to the coefficient of expansion (4) may perhaps be on the high side, it certainly is of the correct order of magnitude, and we must conclude that at the present time it is possible to represent the facts without assuming a curvature of three-dimensional space. The curvature is, however, essentially determinable, and an increase in the precision of the data derived from observations will enable us in the future to fix its sign and to determine its value.

REPORTS

SCIENCE ESSAYS BY HIGH SCHOOL PUPILS[1]

FINANCING THE VENTURE

THERE is a committee of the American Association for the Advancement of Science on the Place of Science in Education. One of the pieces of work in which this committee has engaged related to cooperation with teachers, pupils and librarians in secondary schools. In order to carry out the proposed venture special funds were necessary. Funds were secured as follows:

Commonwealth Fund, balance remaining from a previous grant	$ 417.48
American Association Executive Committee	500.00
Harry S. Bowers	1,200.00
Newcomb Cleveland	1,200.00
John W. Harris and John W. Hegeman	1,200.00
A. Cressy Morrison	600.00
Interest on funds in hand	273.53
Total	$5,391.01

All the clerical service was done in the office of the chairman of the Committee on the Place of Science in Education. The council of the American Association for the Advancement of Science has expressed its appreciation of the committee's work, and the council, the committee, high-school teachers, pupils and librarians appreciate the fine generosity of the individuals who made such substantial contributions to the committee's work. The executive group of the A. A. A. S. Committee consists of J. McK. Cattell, E. R. Downing, I. W. Howerth, B. E. Livingston, Otis W. Caldwell, chairman.

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[2] It seems certain that the pressure p in the actual universe is negligible as compared with the material density ρ_0. The same reasoning, however, holds good if the pressure is not neglected.

[1] We continue to receive requests from schools wanting a repetition of the cooperative work with the A. A. A. S. Committee. It has not been possible to offer this opportunity again. Furthermore, certain types of unprofitable school contests have led to the conclusion that only those which can be designated as useful should receive encouragement from school authorities. We are entirely in sympathy with that policy.—The Committee on the Place of Science in Education.

[3] *Bull. Astronom. Inst. Netherlands, Haarlem,* 6, 142 (1931).

ANNOUNCEMENT OF PLAN

Announcements of the plan were made in educational magazines, and letters regarding it were sent to high-school principals. High-school students were invited to write essays that might possibly be of such quality as to be of interest and value to other students and to the public, or to any one who is interested in the affairs and thought of modern life. It was hoped that the preparation of the essays would be of interest and use to the authors. It was hoped that the effort to prepare superior essays might lead some high-school students to find fields for their own later interests, studies and occupations. It was hoped that an opportunity for attractive and useful juvenile authorship would thus be offered and that the plan would be welcomed by the superior pupils. The best essays would be made the basis of important personal recognitions; also contributions of science books would be made to the libraries of the schools represented by the successful pupils. It was desired to give recognition and encouragement to those young persons who possess unusual interest and capacity for constructive work of high quality.

There were 49 topics announced, upon any one of which work might be done. It was also stated that schools might suggest added topics which could be used if approved by the executive committee. Topics suggested for approval might relate to any science subject or to any applied use of science knowledge or method of work in science. It was thus planned to place before young people the array of modern science, no one science subject being stressed at the expense of any other. It was science, not the sciences, and the appeal of science's ways of working which were placed before the secondary schools. Obviously the committee accepted much more difficult tasks than are involved when a single topic or a few topics in one science subject are offered for competitive essays.

WAYS OF WORKING

One pupil might work alone, or a group might cooperate in production of an essay. Advice might be sought from teachers of science, of history, of English, or from the librarian. Books, magazines and personal experiments could be used. The plan of work was reported to the committee chairman. Then, when the pupils registered their intention of entering the competition, when the essay was finally submitted, the administrative head of each school concerned was asked to submit a signed statement as to the persons and methods used in producing the essay. It was therefore hoped to encourage rather than discourage pupil cooperation in prolonged and earnest intellectual effort. It is regarded as entirely honorable for two or more pupils to work together in scholarly effort, rather than to pretend that intellectual production must be wholly individual. Entire frankness as to how work was accomplished was urged. No case was reported in which objection was caused by this procedure.

BENEFITS POSSIBLE TO COMPETING PUPILS

The satisfactions and encouragement resulting from worthy achievements must be noted as the chief outcomes from preparation of good pieces of work. Then, each of the twenty winning essays won for the school represented a sum of money ranging from $200 to $50 from which to purchase science books for the school's library. These books carry the names of the winning pupils as the persons whose efforts secured the books for future use in the school. Each winning pupil has received a set of the Wells and Huxley's two volumes entitled "The Science of Life." Also each pupil has received a page of autographs of past presidents of the A. A. A. S. This may be inserted in the pupil's prize volumes, or kept by him in some other way, and may possibly become one of his most valued possessions. These pages now carry 11 signatures of presidents of the A. A. A. S. Above all, the pupil through his own directed intellectual efforts may place himself in line for continued growth in scientific interests.

JUDGING THE ESSAYS

How may essays be judged when written in different ways either by individuals or by groups? Many contests have been judged subjectively or superficially, and the A. A. A. S. Committee desired to contribute to improvement in this matter. An unusually competent judging committee was secured to develop a special technique for handling this task. This committee consisted of Dr. G. M. Ruch, University of California, *chairman;* Dr. M. F. Carpenter, University of Iowa; Miss Claudia Crumpton, Detroit High Schools; Mr. N. B. Hammond, Yonkers High Schools; Dr. F. G. Lyman, University of Chicago; Dr. P. M. Symonds, Columbia University, and Miss Lucy Terrell, Cleveland High Schools. No member of the A. A. A. S. Committee on the Place of Science in Education judged any of the essays. The essays were numbered, the author's names being removed. The judging committee's well-organized scheme included the various points of merit or demerit, and assigned numerical values to each element. It is hoped that the scheme for judging will be published as a separate magazine article. After the plan of judging had been developed, two well-trained teachers, one in science and another in English, were employed to make independent studies of all the essays, and to score each essay according to the points agreed upon. Each one of these teachers made detailed record of the numerical score of each essay upon each point of the judging scheme. Finally each teacher-reader summed up his ratings for each essay, then arranged all the essays in order of their rank according to their numerical scores. The essays were then divided into five groups according to their scores. Then a full set of copies of all essays that received scores placing them in the first, second or third groups was sent to each of the seven members of the judging committee. Each member made his independent scoring and mailed his report to the chairman. These scores were combined. The resulting rankings determined the 20 ranking essays. It is thought that such a system of judging does much to eliminate any objectionable features of such contests, and increases confidence that science essays may be judged more accurately than is common, almost scientifically.

THE WINNING ESSAYS

A boy and girl cooperated in more than a year's experimental work, library study and consultation with adults, and produced the highest ranking essay entitled "Rats *vs.* Polyneuritis." Another boy, working alone, won second place with the topic, "My Scientific Experiments—Why I Made Them—What I Gained from Them," and in doing so made for himself and for many others an interesting record of some things that one may do with intellectual profit. Another boy wrote on "The Importance of Protozoa and My Observations of Them," and his essay tied for third place with one entitled "Crystals and Crystallization," which was done by seven pupils who cooperated with their pupil chairman in their chemistry class in the production of their essay. The fifth essay was upon "The Water Supplies of Ancient and Modern Peoples." Other winning topics are: "My Experiments with Hydra"; "A Home in Crude Petroleum"; "The Life and Inventions of Thomas A. Edison"; "The Study of Rats and Mice"; "What Modern Science Means to Me and My Community"; "How Science has Helped Man Overcome his Limitations"; "A Hero of Science—Dr. Jacques Loeb"; "Inventions in Astronomy"; "How has Science Changed my Daily Life?"; "The Relation of Science to the Art of Music"; "Rayon"; "Science and the Home"; "Cellulose and Rayon"; "Products of the Electric Furnace"; "Radium and its Uses." These and many other topics which were submitted prove a wide range of genuine interest in scientific studies. Seventeen states were represented in the whole list of essays submitted, and ten states were represented in the twenty winning essays.

Some mature scientists may argue that secondary school pupils can not deal with topics such as those selected. It is true that some of the winning essays are not highly valuable, though some are quite remarkable in their fine quality. Good essays were desired and some good ones were secured. May I merely comment that during a meeting of the American Association, some papers are presented which do not meet with strong approval by those who hear them, and there have been times when a careful search had to be made to discover productions worthy of the association's annual prize.

LIBRARY REPORTS

Before a school's library could actually secure the funds for purchase of books, the school was asked to send the committee a report on the science books already in the library, what their library needs seem to be, and what they wish to do with the funds when secured. The Enoch Pratt Free Library of Baltimore had prepared an excellent list of science books which the committee sent to each winning library. These library reports are all now in hand except one, and will be published separately.

Science can help itself and its devotees by giving more attention to its recruits at the lower levels. The cooperative essay contest is but one of several ways of making early discovery and giving needed guidance to young persons of unusual capacities and interests.

A LIST OF THE WINNING PUPILS, THEIR TOPICS AND THE SCHOOLS REPRESENTED BY THEM

Rank	Student	School
	GROUP I	
1.	Jane B. Sill Edward H. Reisner	The Lincoln School of Teachers College, New York City
	Topic: Rats vs. Polyneuritis	
	GROUP II	
2.	Daniel Eisler	Glenville High School, Cleveland, Ohio
	Topic: My Scientific Experiments—Why I Made Them—What I Gained from Them	
3.	Ralph Lawrence	The Lewis & Clark High School, Spokane, Washington
	Topic: The Importance of the Protozoa and My Observations of Them	
3.	Lincoln School Chemistry Class	The Lincoln School of Teachers College, New York City
	Winston Hurd, *chairman,* Ernest Landsteiner,	

Frederick Forsch, Kim Plockman, John Steinman, Eugene Williams, Jane Winternitz
Topic: Crystals and Crystallization

GROUP III

5. Byrne C. Manson — John Muir Tech. High School, Pasadena, California:
Topic: The Water Supplies of Ancient and Modern Peoples

6. Dunbar Triplett, Jr. — The Lewis and Clark High School, Spokane, Washington
Topic: My Experiments with the Hydra

7. Wm. Stewart — Beverly Hills High School, Beverly Hills, California
Topic: A Home in Crude Petroleum

8. Katharine Marie Hall — University High School, Ann Arbor, Michigan
Topic: The Life and Inventions of Thomas Alva Edison

GROUP IV

9. John Winslow French — Pawling, New York
Topic: The Study of Rats and Mice

10. Virgil Bolen — Academy of the Western Illinois State Teachers College, Macomb, Ill.
Topic: What Modern Science Means to Me and My Community

11. Rose Auerbach — Washington Irving High School New York City
Topic: How Science has Helped Man Overcome His Limitations

12. Robert Ray — University High School, Oakland, California
Topic: A Hero of Science—Dr. Jacques Loeb

13. David Putnam — High School, Keene, N. H.
Topic: Inventions in Astronomy

14. Joan Elizabeth Boling — Shortridge High School, Indianapolis, Ind.
Topic: How has Science Changed my Daily Life?

GROUP V

15. Matillda Diorio — S. Phila. High School for Girls, Phila., Pa.
Topic: The Relation of Science to the Art of Music

16. John Alloways — Central High School, Kalamazoo, Michigan
Topic: Rayon

17. Freda Becker — S. Phila. High School for Girls, Phila., Pa.
Topic: Science and the Home

18. Omer Widmoyer — Central High School, Kalamazoo, Michigan
Topic: Cellulose and Rayon

19. Wade Allen — Central High School, Kalamazoo, Michigan
Topic: Products of the Electric Furnace

20. Benjamin Richman — Lyndhurst High School, Lyndhurst, N. J.
Topic: Radium and its Uses

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID METHOD FOR OBTAINING SINGLE SPORE CULTURES OF MOLDS

IN the course of a cultural study of a large number of molds it became desirable to procure as rapidly as possible single spore cultures of certain of the hardy, saprophytic molds.

With a modified Chambers micromanipulator[1] a comparatively large number of ascospores of *Aspergillus fischeri* were individually isolated on drops of malt extract agar[2] made on sterile cover slips. The mode of isolation in brief is as follows. A standard research microscope with mechanical stage is mounted on a metal base. To this base, properly aligned, are attached in front of the microscope movable, vertical arms designed to hold the micropipettes with which spore isolation is accomplished. These arms have vertical and lateral fine adjustments, enabling the operator to manipulate the pipettes as desired. The pipettes are made up just before use by drawing out sterile 3 mm glass tubing to the desired fineness in a micro-flame. The extreme tips of the pipettes are bent at right angles to the rest of the shaft. A moist chamber with an aperture on its upper side is placed in the mechanical stage. Two sterilized square cover slips are fitted with edges together over the open top of the moist chamber. On the under side of one cover slip has been placed a drop of sterile agar medium, on the other, a drop of spore suspension. The pipettes, as they are made up, are clamped in the arms in a horizontal position, and their vertical tips are then, by means of the movable pipette arms, brought into the moist chamber and centered under the low power objective. By means of the vertical fine adjustment one of the pipettes is then brought momentarily into the drop of spore suspension and a considerable amount of the liquid with its spore load is taken into the pipette by capillary action. With the mechanical stage the chamber is moved to a clear spot on the cover slip, and a certain amount of liquid expelled, by means of a long blowing tube, to form a small drop on the cover slip. This procedure is continued until a drop is obtained which contains a single spore. The second pipette is then brought into this drop and the spore removed. The drop of sterile agar medium is brought into position and the isolated spore deposited on it. As the spores are isolated, the cover slips with the agar drop and its single spore are sealed with sterile vaseline onto deep hanging drop slides, the well of the slide containing sufficient moisture to prevent drying of the agar, and the whole is incubated at the desired temperature.

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[1] For details as to the use of this micropipette method in the isolation of single cells, see W. H. Wright and E. F. McCoy, "An Accessory to the Chambers Apparatus for the Isolation of Single Bacterial Cells," *Jour. Lab. and Clin. Med.*, 12, 795, 1927.

[2] The nutrient agar used was made up on the basis of 25 g malt extract (Trommer's Analyzed), 15 g agar, 1,000 cc distilled water. The malt broth was made with 25 g malt extract, 1,000 cc water. These media were filtered through asbestos for clarification, but a clear agar is scarcely necessary when germinated spores are picked, as their development may be readily followed on the hanging drop slide.

Early results were most discouraging, as none of the single spores germinated. It was deemed advisable to germinate the spores in malt extract broth, and to isolate germinated spores shortly after the emission of the germ tube, in the hope that growth, once started, would be continued. That the procedure may be successfully applied, at least to some of the common, vigorous forms, is indicated in the accompanying table.

An experienced operator can, with considerable ease and with absolute certainty, isolate 20 or more germinated spores in the course of from three to five hours with the use of this micromanipulator method, so that it is apparent that single spore cultures of many organisms can be accumulated with considerable rapidity.

Growth of Single Germinated Spores

Organism	Germinated spores isolated	Spores continuing growth	Per cent. continuing growth
(Ascospores)			
Aspergillus fischeri	8	5	62
(Conidia)			
Aspergillus fischeri	17	10	59
(Conidia)			
Aspergillus nidulans	8	3	37
Aspergillus sydowi	12	6	50
Botrytis sp.	8	7	87
Hormodendron sp.	12	12	100
Monilia sitophila	8	8	100
Penicillium digitatum	12	3	25
Penicillium islandicum	8	7	87
Syncephalastrum sp.	11	8	73
Trichoderma sp.	9	5	55
Totals	113	74	Av. per cent. = 65

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A METHOD FOR DETERMINING THE VOLUME OF SMALL PIECES OF TISSUE

A series of test-tubes of varying sizes have each a capillary tube drawn off from one side, as shown in Fig. A. With the tube retained in a perpendicular position fluid is run into the tube to a point above the lower outlet and then brought down to this exact level by air pressure exerted through the mouth of the tube. For greatest simplicity direct mouth pressure has satisfactorily served this purpose.

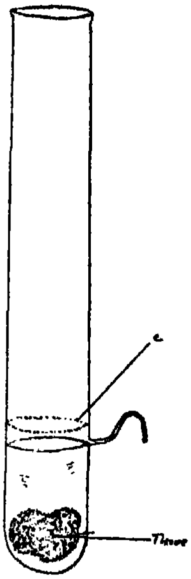

Fig. A

The tissue is then immersed in the fluid, and in accordance with the principle of fluid displacement, a new level is established at "C." By a procedure similar to that described above, the displaced fluid is collected through the capillary tube and its volume estimated.

Temperature and barometric corrections are hardly necessary, since in volumes as small as can be measured by this method the errors are negligible.

By this method volumes as small as one tenth of a cubic centimeter have with ease been estimated. It is, however, essential to use a test-tube whose diameter is only slightly larger than that of the tissue in order to secure a maximal rise of fluid and minimize error.

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ALOXITE AS AN ABRASIVE FOR GRINDING BONE SECTIONS FOR HISTOLOGICAL PURPOSES

Sections of dry bone for histological study are prepared usually by one of the following methods: Grinding on a lathe, on compact pumice stone, on sand—or carborundum—paper of different grades of fineness, and lastly, on or between stones of suitable fineness. These methods are suitable but slow and tedious.

In the course of preparation of bone sections, the writer has found that aloxite powder (crystalline alumina) possesses exceptional abrasive properties for rapidly reducing bone to any desired thinness.

The technique here given has been found most satisfactory and particularly suitable for classroom use because the student can grind sections for himself quickly and inexpensively. Thin sections of about 1 mm in thickness are sawed with a hack saw and given to the students who grind them on glass plates (discarded lantern slides make suitable plates) with aloxite powder and water. The quantity of water used is just enough to maintain the powder in a pasty consistency during the grinding. Ordinary corks are used to hold the sections during the process. The grinding should be conducted by frequently alternating the surfaces, thus insuring more uniform thinness and better finish. When the sections become transparent or of tissue-paper thinness, they are polished by dipping in water, blotting dry and rubbing carefully with finger on a carborundum or greenstone hone. This last step is necessary so as to fill the lacunae and canaliculi with débris. The sections are mounted, as usual, in gelatin.

Comparative trials show that aloxite used as described cuts twice as fast as the fastest of the other above-mentioned abrasives. No more than ten minutes should be required to completely grind and mount a section.

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SPECIAL ARTICLES

THE CENTRIOLE OF THE AMPHIBIAN LEUCOCYTE

IN 1926 Belar published his observations on the centrioles of the perihepatic leucopoietic tissue of Salamandra. These studies were made by the Flemming-hematoxylin method and demonstrated the fact that a cell in the interphase contains two centrioles which have been derived directly from telophasic division of a single centriole at the pole of the mitotic spindle and that during a subsequent prophase these two centers of the non-dividing cell separate and become located at the poles of the spindle. Belar's series of figures illustrating this genetic continuity of the centriole is so completely demonstrative that it is difficult to understand why these very significant results have not received more attention in recent discussions of the central body problem.

I have repeated Belar's observations on Salamandra and have extended the study to other Urodeles, namely: Amphiuma, two species of Amblystoma, Triturus and Siren. Material was fixed in the fluids of Champy, Flemming, Benda, Helly, Bouin, and a saturated solution of corrosive sublimate in normal saline. Staining was by means of iron hematoxylin, Kull's acid fuchsin-thionin-aurantia and Benda's alizarin-crystal violet. The facts are demonstrated by any of these combinations, but the Benda method is most useful, since it stains the centrioles a distinctive color, unlike that of any other structures in the cell.

This extensive reexamination completely confirms Belar's results and in my opinion incontestably establishes the fact that the centrioles maintain direct visible genetic continuity through all the numerous cell generations in the differentiation of the mature leucocytes. This general conclusion holds for the six types examined, but in minor details there are differences among the genera. The following brief description refers, in all its details, only to Amphiuma.

The myelocyte in the interphase contains a single large aster. The Golgi apparatus is closely applied to this structure, and chondrioconts in its vicinity are oriented so that their axes are radial to its center. At the focal point of the astral rays is a spherical zone that stains considerably more heavily than the general cytoplasm, and which I shall more or less arbitrarily call the centrosome. Outside this zone and considerably excentric with reference to the focal point of the astral radiations are two granules which stain very intensely and which I consider are most accurately termed the centrioles. These have so great an affinity for hematoxylin, acid fuchsin or crystal violet that slides can be extracted until the centrioles are the only stained objects outside the nucleus. Both centrosome and centrioles are well preserved and may be stained after such fixatives as Champy's fluid, which preserves not the least trace of an aster. In early prophase the centrioles seem to enlarge slightly and then they move apart. A spindle forms between them, and upon breakdown of the nuclear membrane the chromosomes become arranged in the metaphase plate. The centriole at this stage is exactly at the focal point of the spindle fibers, but I wish to forestall any possibility of a suggestion that it is their coagulated focal point by stating that in Benda preparations the spindle fibers are light orange, while the centriole is a brilliant purple. The centriole in this material is far more clear-cut and definite than any I have ever seen. Its size and spherical shape are constant. In the early telophase, after disappearance of the polar part of the spindle, the centrosome and astral zones are reformed around the centriole, and in middle telophase it can first be clearly seen that the centriole has divided. At first these division products are very small and close together, but in late telophase they move apart somewhat and enlarge to the size which they maintain throughout the interphase.

The above description is based upon examination of certainly hundreds of thousands of leucocytes of Amphiuma. The results may seem more convincing to some cytologists when I state that I have found not one cell inconsistent with this outline of the history of the centrioles. The only cells in which these facts are not easily observable are those where the staining is either so heavy as to obscure all details or so light that there is no differentiation of structures in the cytoplasm. I have slides, prepared by the Benda method, in which the stain has been extracted to such a degree that the centrioles are a faint blue and even then it is always possible in every cell to make out these "ghosts of centrioles" exactly where one would expect to find them. On any properly stained slide every cell demonstrates the centriole situation to be as I have described above.

It is perhaps also worth mentioning that I have observed many mitotic figures in the hepatic glandular cells on the same slides with the leucopoietic tissue. The centrioles, always present at the poles of these spindles, are identical in size and staining characteristics with those of the leucocytes.

In conclusion let me emphasize the aspects of this case of the leucocyte that make me consider it highly significant for the whole centriole problem in its present state. First, it demonstrates the individuality and genetic continuity of the centriole in somatic tissue of adult animals by the use of a wide variety of technical methods. The more general significance of this is that the centrioles are the only part of the mitotic apparatus that persists from one cell generation to the next. Second, the centrioles are not the coagulated focal point of the spindle fibers, because the histories of these two structures are very different and because there are marked differences in staining reaction. Third, the centrioles are not the coagulated focal point of the astral rays, since there are differences in fixing and staining reactions and especially because the interphase centrioles are *double* and placed *excentrically* inside a *single* aster.

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LEAF TEMPERATURES OF COTTON PLANTS WITH PHYMATOTRICHUM ROOT ROT[1]

THE leaves of cotton plants that have wilted from *Phymatotrichum omnivorum* root rot are so regularly and so definitely warmer than those of normal plants that the writers have been able to utilize this difference in leaf temperatures in diagnosing cotton plants about to succumb to the effects of the disease.[2] It has therefore been of interest to find the actual differences in temperature between leaves of cotton plants with root rot and those of normal plants. The observations recorded below have been made on plants of Startex cotton (Texas Station No. 7000) growing in experimental plats at College Station, Texas.

MEASUREMENTS WITH MERCURY THERMOMETERS

Two ordinary chemical thermometers, previously tested and found to register the same temperatures and to respond at the same rate to changes within the range used, were mounted inside an insulated cardboard box, free of the sides, and used for simultaneous readings on leaves from root-rot and from normal plants. This box was carried around the field to the plants, care being taken to have the open side of the box away from the sun and the thermometers thus always shaded. The leaves were selected from adjacent plants, similar in size and other characteristics except that one had wilted from root rot while the other was apparently normal; and each of the pair of leaves to be compared was selected of the same size, height on the plants and exposure to the sun. Each leaf was cut off the plant with small scissors, grasped with forceps, doubled together rapidly, and the doubled leaf then folded around the bulb of the corresponding thermometer. An insulating cardboard cover was immediately slipped around the bulb and leaf, and clamped loosely in place. The entire operation took ten seconds or less, and the leaf was touched only with the implements which were all kept in a shaded compartment of the thermometer box when not in use. Immediately before putting the leaves on the thermometers, the air temperature was read and recorded for each thermometer; after clamping the leaves in place, readings were taken at intervals of 1 minute for 3 or 4 minutes. The thermometers usually showed a rapid change during the first 30 seconds, but after 1 minute the equilibria reached usually remained unchanged for 5 to 10 minutes or until the thermometer bulbs were again exposed to the air. The thermometers were alternated, each being used first for the leaf from a normal plant and then for the leaf from a root-rot plant. On account of this alternation, any unobserved lag in reaching equilibrium with air temperature would have tended to decrease rather than to accentuate the differences found between the leaves from the normal plants and those from the wilted plants.

Measurements with mercury thermometers were made on July 15, on a bright, sunny afternoon, and again on July 21, 1930, early on a partly cloudy morning. On both occasions, the leaves from normal plants were usually definitely cooler than air temperature, while leaves from the diseased plants were usually as warm as air temperature or slightly warmer. Thus with one pair of leaves, the leaf from the root-rot plant raised the thermometer to 101° F. from an initial air-temperature reading of 100° F., while the leaf from the normal plant lowered the reading to 95° F. Invariably, leaves from the plants with root rot were at least slightly warmer than the corresponding leaves from normal plants. The differences between the temperatures of individual pairs of leaves ranged from 0.5° to 6.0° F. higher for leaves from the plants with root rot than for the corresponding leaves from normal plants. The average difference for 11 pairs of cotton leaves was nearly 3° F. Two pairs of leaves from adjoining normal and root-rot fig trees similarly showed differences of 2.5° and 3° F.

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[1] Published with the approval of the director of the Texas Agricultural Experiment Station as Contribution No. 177, Technical Series, of the station.

[2] J. J. Taubenhaus and Walter N. Ezekiel, "Cotton Root-rot and Its Control," Texas Agr. Exp. Sta. Bul. 423, 1931.

MEASUREMENTS WITH THERMOCOUPLES

Some thermocouple measurements were made later in the season, using a large portable demonstration galvanometer and a multiple thermocouple outfit (designed for radiation measurements).[3] The sensitive units consisted of two flat plates, each containing 26 antimony-bismuth thermocouples mounted flat on the plates. The larger disks in which the thermocouple plates were set were mounted about 25 mm apart, facing in opposite directions. The entire outfit was taken into the field and used inside a shaded box. Each measurement was made by pressing the selected leaf, folded, against one of the thermocouple plates, using a soft pad to hold it against the entire surface; while the other thermocouple plate was always at air temperature. Deflection of the galvanometer was thus directly proportional to the differences between the leaf temperatures and air temperatures. The sensitivity of the outfit was such that a deflection of one division (nearly 1 cm) on the large scale was equivalent to 2.25° F., and accurate readings could be made to about 0.5° F.

Measurements made on September 15, 1930, with the thermocouples, agreed in general with the previous results. Leaves of the normal cotton plants were generally cooler than air temperature, ranging from 2.5° above air temperature to 4.5° below and for 11 leaves averaging 1.5° F. below air temperature. Leaves from root-rot plants varied from 1.3° below air temperature to 6.5° above, with the average for 24 leaves at 1.2° F. above air temperature. The average difference between temperatures of the leaves from normal and root-rot cotton plants was thus nearly the same as in the July series. Thermometer readings of temperatures of leaves from some of these plants, taken periodically, agreed fairly well with the thermocouple readings.

Increase of temperature of cotton leaves has been shown by Eaton and Belden[4] to be closely correlated with decreases in the transpiration rates; and they note also (p. 11) that increase in temperature of cotton leaves, wilting in this case from a shortage of soil moisture, may become perceptible to the touch several hours to a day in advance of visible wilting of the leaves. There can be no doubt that the heightened temperatures of the leaves of plants with Phymatotrichum root rot are similarly due to the decrease in water supply, which agrees with the usual conception of the immediate cause of death of plants from this disease. The assumption is that plants succumb as the result of mechanical interruption of the transpiration stream by the rotting of the roots. This breakage of the flow of water, often just below the surface of the ground, is so marked that we have frequently observed, around the base of freshly-wilted cotton plants, the exudation of water in amounts sufficient to wet the soil around the plants, this exudation from the injured portions of the roots presumably being induced by the continued pressure from the uninjured portions of the roots below the area involved by the disease.

SUMMARY

Leaves from plants wilted from Phymatotrichum root rot were as much as 6.5° F. warmer than air temperature, while leaves from normal plants were usually cooler than air temperature. Series of measurements made with mercury thermometers and by thermocouples showed that in July and in September, 1930, leaves from root-rot cotton plants averaged about 3° F. warmer than leaves from normal plants.

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[3] This equipment was made available through the courtesy of Dr. O. W. Silvey, head of physics department, A. and M. College of Texas.

[4] Frank M. Eaton and Galen O. Belden, "Leaf Temperatures of Cotton and Their Relation to Transpiration, Varietal Differences, and Yield," U. S. Dept. Agr. Tech. Bul. 91, 1929.

SCIENCE

VOL. 75 FRIDAY, APRIL 15, 1932 No. 1946

Eutopotropism:—Sense to Find the Fit Place: PROFESSOR ALFRED C. LANE 393

Obituary:

George Eastman: PRESIDENT KARL T. COMPTON 402

Scientific Events:

The Copyright Bill; Progress in Research at Mellon Institute during 1931–32; Princeton Chapter of Sigma Xi; The Ohio Academy of Science; Societies and Sections Meeting at the Syracuse Meeting of the American Association 406

Scientific Notes and News 409

Discussion:

The Fifth Florida Whale Shark: DR. E. W. GUDGER. *The Whale Shark on the Coast of Borneo:* DR. ALBERT W. HERRE. *Determinism and the Weather:* PROFESSOR ROBERT C. MILLER. *On "Academic Freedom in Italy":* PROFESSOR GIUSEPPE MONTALENTI. *Academic Freedom in Spain:* P. H. YANCEY 412

Scientific Apparatus and Laboratory Methods:

A Method for Washing Corpuscles in Suspension: C. A. LINDBERGH. *A Modification of the Buchner Method of Cultivating Anaerobic Bacteria:* A. M. GRIFFIN 415

Special Articles:

Phosphate, Nitrate and Nitrite in the Sea-Water of Regions Adjacent to Cape Cod: PROFESSOR NORRIS W. RAKESTRAW. *A Method of Immunization with Carbohydrate Haptens Adsorbed on Collodion Particles:* DR. JULES FREUND 417

Science News 8

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EUTOPOTROPISM:—SENSE TO FIND THE FIT PLACE[1]

By Professor ALFRED C. LANE

TUFTS COLLEGE

MY subject is Eu-topo-tropism. I imagine some of my profaner hearers will be inclined to say, "What in hell is eutopotropism?" To which I would reply, "It is not in hell."

Others more literary may ask, "In what dictionary is it?"

To which I would reply: "It is not in any dictionary. I made it up." I made it up to shock you so that you will remember the idea, for although the word is new, the idea is not.

Eutopotropism is the tendency or sense to know where you are well off and go there, the sense to find the fit place. It is the opposite of the trait exemplified by the June-bug who will "buzz and butt his head against a wall" or the moth that "shrivels in the fire."

I have an aim or a purpose, and my action is not determined by the past, but is determined by the future. I will call it by a word that you never heard before, that I invent for this occasion, eutopotropic. It means turning to the place where you are well off. The capacity to be eutopotropic *is a sign of intelligence*. For evolution by natural selection to work there must be three things —a variation, an environment where that variation fits, and, third, a disposition to occupy that environment. It is this third factor that I call eutopotropism. An extra coat of hair fitting an elephant to be a mammoth and live in the Northern part of Asia would not lead to a race of mammoths unless with the extra hair went a disposition toward a northern climate. It is this sense enough to know where you are well off and go there that I call eutopotropism.

---

[1] Address of the president of the Geological Society of America given at Tulsa, Oklahoma, December, 1931.

> Such behavior leads us to infer intelligence, whenever we can more easily infer actions from aims in the future than from causes in the past.[2]

The derivation is obvious to one familiar with English science or Greek roots. Heliotrope is the flower *that turns toward the sun*. At the Tropic of Cancer the sun turns backward in the heavens. The biologists have a string of terms ending in "tropic" and "tropism." A "tropism" is a turning, or an inherent tendency of a living organism to turn in response to an external stimulus.

J. Loeb, in his book on "Forced Movements, Tropisms and Animal Conduct," has a long list—of helio- *geo- stereo- chemo- thermo- rheo-* and *anemo-*tropisms —but he does not mention our eutopotropism, because he is not strong on intelligence, perhaps?

Eutopia I spell with an E to distinguish it from the Utopia of Sir Thomas More and other visionaries. His Utopia was supposed to be the land where everything was well, and as there is no such place, the name was derived from the two Greek words οὐ, not, and τόπος, place. The word τόπος, which we have also in the word "topography," is also a root in eutopotropism. But the first syllable is from the Greek εὐ, well, which we have in numerous other English words, as "eugenic," well-born, "euphonic," well-sounding.

Thus eutopotropism is the sense or tendency to turn to the place for which the organism is well fitted, to which it is preadapted. This place may be—indeed, it certainly will be—less fitted to other organisms. It is not a general Utopia, but it is a logical next step to the theory of preadaptation, as developed by Cuenot and Davenport, to consider for what the organism is preadapted and what it will do.

They pointed out that when an individual varies from its forebears, it will often do so in a way that makes it better fit and more able to survive in some particular set of surroundings before it is in them. If it comes to be in that particular set of surroundings, it and those similarly varying will there thrive. But will they have sense enough to go there or to stay if they find themselves there?

I use the term sense, because, ordinarily speaking, we regard behavior that takes you where you are well off and to the place for which you are fit as sensible, and the opposite tendency to kick against the pricks and to butt your head against a stone wall as unintelligent, or senseless. Perhaps others may prefer a longer word. Do not miss the idea, whatever you prefer.

I have chosen this subject as of interest not merely to us as geologists but to all of us as individuals and as members of the body politic. For we were men before we were geologists, and as we are composed of cells, in whose harmonious and fit cooperation is our bodily health, so we are but unit cells in that greater organism of society called the United States of America. It is well that we should find our fit place in it and that the whole nation should find its fit place in the family of nations.

But, granted that the subject is one of interest and importance, why is it fitting that I should select it on this occasion, which perhaps is the greatest opportunity of my lifetime to reach a wide, an intelligent and an influential audience. What has geology to do with it? Let me explain how I came to select it.

I trust you have not honored me with this high office simply because I have lived long enough to have arrived at years of discretion, nor because you think I will not bore you with too long an address and think that I have learned that brevity is the soul of wit, but because you also think that I have contributed *somewhat to the science to which* we are devoted.

If I had some great epoch-making geological discovery of my own to announce, it would be well to throw the limelight of this brilliant occasion upon it.

But Osler has suggested that new ideas do not come after sixty, and others have put the date as early as thirty. Failing such a discovery, it is natural to look over one's life and see which work of value seems to have been least appreciated.

I remember my old teacher Shaler at about this time of year, the time of the January mark-down sales, said to me: "Lane, I find at the end of the year I have a job lot of hypotheses that I would sell very cheap!"

So toward the end of life it is natural to look over ideas to see which have been sold and which, though still unsold, you consider valuable—not cheap, but such as you would commend to the attention of a discriminating audience.

Six years ago I coined the word eutopotropism in the heat of a verbal talk to students.[3] Thirty years ago I discussed the early surroundings of life and their evolution and the way life has adapted itself to the change,[4] and before that I had discussed the importance of individual choice in evolution.[5]

Indeed, I might go farther back. It is well-nigh forty years since I first addressed this society on the rôle of the earth's originally absorbed gases.[6] In some respects the conception of the rôle of the earth's originally absorbed gases there defended doesn't need to be brought up again. It is sold!

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[2] "Some Contacts of Geology and Religion," *Harvard Alumni Bulletin*, Feb. 26, 1925.

[3] *Harvard Alumni Bulletin*, Feb. 26, 1925.

[4] SCIENCE, Aug. 2, 1907, p. 129.

[5] SCIENCE, May 4, 1906, p. 702, and *Outlook*, Vol. 58, p. 479, 1898, "Of Pegs and Holes, Individuality in Evolution."

[6] *Bul. Geol. Soc. Am.*, Vol. 5, pp. 259–280, 1894.

That volcanic magmas contain gases and yield waters which do not come from the surface of the earth is now generally accepted, though as late as 1905[7] my old teacher Shaler said of outbreaks of volcanoes:

> This action appears to be due to the inclosure of water in the stratified rocks at the time when they are laid down on the sea floor; this crevice water becomes heated as the rocks become deeply buried, and by the central heat is brought to an exploding strain.

This possible source of some volcanic activity, illustrated in the frontispiece of Lyell's geology, is now almost entirely ignored. The works of Day, Allen, Fenner, Shepherd, Zies and their coworkers of the Geophysical Laboratory have thrown much light on the magmatic gases.

It is, however, a fair question on which we need more light which I commend to your consideration. What does become of the connate waters or petroleum when a sandstone is converted to a quartzite or a clay to a schist?[8] In the process of compaction, where and when and how do they go?

The rôle of magmatic gases and of juvenile waters is so well understood and so widely accepted now that I will bore you only for a few moments by recounting the evidence on one particular line of activity before I take up my main and more interesting theme, which is their effect on life.

These gases have a rôle in the crystallization of igneous rocks affecting not only the coarseness of grain of the igneous rocks and the minerals of the igneous rocks, which form from a rock magma as candy from syrup, but also affecting a wet and dry differentiation.[9] Hornblende and micas replace pyroxene and olivine, and the feldspar formation is prolonged as the magma gets wetter, with a consequent shifting of the eutectic or cotectic troughs and of the chemical character of the residual magmas available for differentiation. Much has been learned since 1895, and the recent president of the Association of Petroleum Geologists, Sidney Powers, has helped me to contribute thereto.[10]

Yet any treatment of rock crystallization and differentiation that would satisfy me and the severe and competent critics that would be in this audience would need mathematics and figures and diagrams, if it is to go beyond some such simple statement as above made, or a statement that the hotter the initial temperature of an igneous rock and its county rock are, and the more the mineralizers, the less pronounced will be the marginal belt of finer grain, while the general effect of the retention of these mineralizer gases is very much as though the temperature of crystallization was shifted toward that of the county rock and away from that of the original molten rock.

I remember that Professor Lindgren has complimented me as a "reformed mathematician." I must not backslide. So I put aside another subject. Geologic time, for instance, has much interested me and it would not be unseemly that, on the one and only occasion when a member of this society rises to the dignity of an American Senator and can take all the time to talk that he wants, he should take time for his subject. But I have recently spoken on time[11] and against time by radio. Dr. A. Holmes will treat it in his forthcoming Lowell lectures. Knopf's Bulletin 80 of the National Research Council has just given a masterly treatment. Finally, I do not think that I can handle the forty odd methods of estimating geologic time that I have listed, in a fashion to suit me without many figures, some mathematics and several hours! Gladstone, they say, could make a budget interesting, but I am no Gladstone, and I put it aside.

Before we discuss the way life has been affected by and has met the changes produced by the progressive inorganic evolution which these escaping gases have caused, let us first consider what signs there are of such an evolution and reasons for believing in it.

Returning to this exudation of gases from the interior, I would ask: If there has been a continuous supply of gases from within added to the ocean of air and of water and also a precipitation from the ocean either directly or by deposits due to organic life, would it not be a very striking and remarkable balance if there had not been some change in the oceans of air and water and an inorganic evolution in the sediments formed in them as well?

The more active of these gases will be combined and largely precipitated. For instance, the carbon dioxide so common in volcanic gases will be the food of plants, and the chlorine and sulphate will combine with bases.

But the more inert nitrogen and the rare gases will accumulate. Therefore, we are not surprised to find that they form a large part of our atmosphere.

If we find signs of glaciation and a more rigorous climate in early times, one factor may be that there was less atmosphere then. A rise of 300 feet in the atmosphere means a drop in average temperature of something like a degree. Thus the climate in times past must have varied with the amount of atmosphere. Taking away three thousand feet of atmosphere might well bring on another ice age if it meant lowering the snow-line 3,000 feet. This may have counterbalanced any possible greater heat on the sun. The diameter of the sun was very likely greater and that would tend to equalize the temperature at different latitudes. The brightness or amount of heat would tend to equalize the temperature at different latitudes. The brightness or amount of heat per unit of its area is likely also to have varied. Possibly for the former reason, but very likely more from a different distribution of land and water, climatic zones seem not to have been as marked in the remote past as at present.

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[7] Shaler, "Man and the Earth," p. 170–171.

[8] *Bul. Geol. Soc. Am.*, Vol. 24, p. 704, 1913.

[9] "Wet and Dry Differentiation," Tufts College Studies, Vol. iii, No. 1, 1910, pp. 39–53.

[10] *Bul. A. I. M. E.*, No. 110, 1916, pp. 535–548.

[11] *Scientific American*, Feb., 1930; *Scientific Monthly*, Apr., 1931.

If the crust of the earth was ever hot enough to vaporize all the water in the ocean and the ocean was anything like its present ocean, the temperature at the base of this very heavy atmosphere might be far above 100° C. and near the critical temperature of water, 374°. The water would remain gas until cooled down to that temperature. Thereafter from that point the rock surface temperature would slowly drop, a process ignored by Lord Kelvin.

I do not, however, personally believe that the early ocean, either of water or air, had the volume of the present. If Foqué was right in estimating that one of Etna's minor parasitic cones emitted in 100 days 2,100,000 cubic meters of water, in 600 years it would discharge a cubic mile. Thus only a hundred such vents would suffice to discharge all the 300 million cubic miles of sea water in the 1,800 million years or so in which it seems likely we have had plenty of time to have discharged the ocean.

Of volcanic gases the vast bulk is water.[12] Some of the water gas might be absorbed in hydration of the rocks. But the crust of the earth, ever near enough to the surface to be hydrated, must be much less than 10 km[13] and much less than 5 per cent. by weight of the 10 km can be water. This would be about 2 per cent. by volume, so that the water absorbed in the crust must be less than 200 meters, no great addition to the volume in the ocean.[14] Most of the water exuded from the interior must be still in the ocean, whose volume is continually increased by volcanic emanations. I know no signs that the earth is absorbing the oceans or that they were once deeper than now—quite the contrary.

The next most abundant gas is carbon dioxide. This can be and is precipitated directly as calcium magnesium, ferrous and other carbonates. As soon as plants were available, it would be decomposed by them into vegetable fiber and oxygen.

To be sure, vegetable fiber may be eaten and oxygen breathed by animals and reunited. Yet insofar as we find carbonaceous matter of organic origin in the crust of the earth, petroleum, coal, peat, natural gas, etc., we may reasonably look for the oxygen which went with it, when the carbonaceous matter was reduced by plants from CO_2. Some of it goes into oxidation of the red rocks, as C. H. Smyth[15] has estimated. But this will not account for all. For the balance we may look to the amount of oxygen in the air, some four pounds per square inch, though, as we really know nothing as to how much carbon there is beneath the three quarters of the earth's crust covered by the oceans, an estimate might well be characterized as three hops of hypothesis, a skip of computation and a jump to a conclusion!

Nitrogen of the volcanic gases must also accumulate, mainly in the atmosphere, for the amount in the rocks and waters is much less than the carbon dioxide. Here again it may be possible to compute whether the nitrogen in the air is to the water of the ocean and the oxygen of the air as the analyses of volcanic gases would lead us to expect. The sulphur may be represented in the sulphates of the ocean, the anhydrite and gypsum of the land and in the widespread sulphides. The chlorine is partly represented in the salt domes and the salt water of the strata and the chlorine of the ocean. When first delivered, whether as HCl or Cl, it would naturally attack the bases in the order of their abundance and ease of attack. Calcium and iron chloride would be more abundant than sodium chlorides. But when it comes to precipitation, calcium, magnesium and iron are surely deposited from the ocean more than the sodium. It will be a rare drilled well in which there is not more lime than soda in the cuttings. Therefore, there will accumulate in the ocean an increasing proportion of sodium, while in the early ocean there was a relatively larger proportion of earthy chlorides.

While we can not say offhand that the ocean would be growing saltier, since that would depend on the relative supply of water or base exchanges, the precipitation effect of organisms and other factors, it seems almost certain that there has been an increase in the proportions of sodium to chlorine. Moreover, all lakes without outlets tend to grow saltier. Why should that great salt lake called the ocean be an exception? The very old and very salt waters that are sometimes encountered one would have to explain as the residue after the hydration of volcanic glass and the formation of chlorite.[16]

But all this is a deduction from the general idea of exudations from the interior. Are there any facts

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[12] *Shepherd Bul.* Hawaiian Volcano Obs., viii, 5, 1920, p. 2, other papers of this observatory and various papers of the Geophysical Laboratory.

[13] Clarke, "Data of Geochemistry," *U. S. G. S. Bulletin*, 770, pp. 32, 34.

[14] M. L. Fuller and others cited in Clarke, *ibid.*, p. 35, make it perhaps 1 per cent. of the ocean.

[15] *Jour. Geol.*, 13, 1905, pp. 319–332.

[16] *Bul. A. A. Pet. Geol.* 11, 1927, p. 1283–1305.

to substantiate this idea? I think that critical study of analyses of waters, and other facts support it.

The question how we can distinguish between the waters circulating down into the rocks now or from past land surfaces, the connate waters originally laid down in the rocks, and these juvenile waters which have emanated from below from invasions of igneous magmas—has been on my mind. It might well be the subject of a course of lectures. But it involves a detailed consideration of analyses of the waters. Many of you perhaps, like myself, can not very well understand figures by hearing them. I have to see them to understand. Perhaps some of you hate figures, anyway. Moreover, there are men here who have vastly more material at their disposal than I, who will take it up and by careful study of water analyses will be able to distinguish buried land surfaces which have been leached and filled with a water quite different from that which originally filled the beds. So I shall not go into the matter in detail on this occasion, though I should be glad to take it up with them individually. I look to a time when, with wide-spread use of accurate analytic methods, we shall find the rarer ingredients also significant, iodine perhaps rarer in the older rock. We might, in the age of the surrounding strata, find a reason for the low iodine and prevalence of goiter around Lake Superior. The distribution of Sr may also be significant, and the concomitant gashed dolomites.

I expect to see old land surfaces and disconformities recognized by the associated waters. I suspect that, as in the Red Coulée field of Canada,[17] they will be marked by a lower concentration and an increase in other acid ions relative to chlorine, and in sodium as well. Perhaps also, as R. L. Ginter suggests, organisms coming in from these old land surfaces may be traced by their biochemical reactions.

Again, while I do not propose to bore you with detailed discussion, are there not signs that in the earliest rocks, the Keewatin, or "greenstone schists," as they used fitly to be called, we have a formation which does differ significantly from the later rocks? There are less signs of contemporary oxidation. The abundant lava flows lack the reddened top of later lavas. Sedimentary carbonaceous beds are rare or absent. So seem to be red beds of any kind and red gangue or flucan, or hematites that might be considered laterites.

We do not find beds of salt or gypsum or metamorphic equivalents of these in the Precambrian. I think the ferrous carbonates are more common in the Precambrian, which would be natural if this early atmosphere was not so oxidizing.

In this early period when there was little or no oxygen in the air, air-breathing animal life would be relatively absent. If we may carry over into geology the distinction made in college catalogues between biology and zoology, we might say that there was an early Azoic but not Abiotic Era. In the early Precambrian Keewatin rocks signs of animal life, at any rate, are rare.

I am convinced that the Precambrian limestones are akin to the so-called "shell marls" which my lamented friend, Charles A. Davis, studied for me[18] and showed were mainly the product of lime-depositing plants. We agreed that the same origin might apply to Precambrian.

It seems to me probable as a "hunch" that, while life began in a rather peculiar and individual environment, which the chemist and biologist after much experimenting have not yet been able to reproduce, it has gradually varied to fit varying environments and found a profit in new reactions, chemical and otherwise.

For instance, it seems as though in the later Precambrian, at a rather definite time in the earth's history, not the very beginning, the algae began to throw out lime carbonate, as the stoneworts (characeae) do now in our marl lakes. It was somewhat later that the organisms studied by E. C. Harder,[19] the iron-precipitating bacteria, learned to find a profit in the precipitation of iron oxides and initiated a world-wide age of iron deposits, and it was later yet before the conditions for them were so favorable that they abounded, as did the potato bugs about 1880, when I saw a windrow three inches high along high tide and as far as the eye could see along the Atlantic coast.

Still later, as Daly has pointed out,[20] came fishes, and a scavenger system was developed with a change in the quality of limestone. F. W. Clarke has also pointed out the effect of temperature in changing the proportions of lime and magnesia included in the shells of sandy animals.

As we have said, volcanic waters are generally acid and the ocean water is practically neutral. The rivers are high in sodium, lime, etc., combined with sulphate chlorine and CO_2 mainly, but a small amount of SiO_2. On reaching the ocean, the lime carbonate may largely be precipitated as limestone (directly or more likely indirectly), but the sodium carbonate or silicate may be thought of as converted into sodium chloride, while the silica is converted into the tests of the diatoms and the CO_2 is used by life in one way and another.

In the ocean the tendency to an increase of the ratio of sodium to chlorine was probably not uniform, for rainy climates and large land areas would furnish sodium more rapidly, while a large precipitation of salt would leave a residue in which the earthy chlorides were more abundant.

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[17] *Bul. Can. Mining Institute*, Nov., 1930.

[18] *Jour. Geol.*, 1900, Vol. 8, 1900, pp. 485–497.

[19] *U. S. Geological Survey*, Prof. Paper 113. See also Lane, *Geol. Mag.*, 1908, p. 485.

[20] *Bul. G. S. A.*, 20, 1909, pp. 153–170.

R. B. Newcombe tells me that a well at Muskegon, Michigan, 4,715 feet deep down to the St. Peter sandstone, has 59,785 of Na and K to 168,000 of Cl, a ratio of 0.353, while wells higher geologically (in the Devonian), but just as deep, have a higher ratio of Na to Cl. For instance, in a well near Midland, practically as deep down to the Sylvania sandstone just below the Devonian (4,697–4,700 feet), the ratio had risen to 0.4, and in the present ocean the ratio is 0.65.

In connate waters of the later Paleozoic, the ratio is usually from 0.44 to 0.53, as found by Reeves.[21] We must, however, remember that these and other buried waters struck by the oil wells have generally been more or less altered by diagenetic changes, by bacteria buried with them, or introduced later by circulation since burial of the strata, not by any means necessarily by circulation from the present surface, but by circulation from some ancient land surface which in leaching the limestone left it full of pores and caves and underground water channels[22] in which later petroleum could collect, ready to gush out when trapped. Such changes from old land surfaces in most cases seem to raise the proportion of sodium and of acid radicals other than chlorine, even though water is absorbed. For instance, the St. Peter's sandstone shows a fresh water 2,000 feet down. I have no doubt the normal oceanic Na : Cl ratio of St. Peter's time is less than 0.35 and nearer that of the Keweenawan, which seems to be near 0.08—the ratio of the time when hard parts and land animals may have developed, as we shall see.

But what about the life that has existed in this changing physical environment of the ocean?

While the single-celled forms multiplied in the water which brought them their food, those which showed they had a capacity to cooperate to help the circulation of sea water around through the mass had an advantage which led to the porifera or sponges which have a circulatory system which ultimately led to that of the blood of our veins.

Even though there was life even in the hot waters of the geysers, the chances are that somewhat cooler and somewhat less acid waters would on the whole be better for the activity of the protoplasm. While in the beginning there would be no limey shells in the acid or soft waters, and no tendency to produce them and if produced they would have been promptly dissolved, the time would come when the concentration passed the physiological optimum which doctors tell us is about eight parts per thousand. Then what? Some of the organisms would secrete some of the extra salts. If they were secreted internally, they might serve as a skeleton support. If they were secreted around the outside, they might serve as a shell-like protection. A leathery or shell-like protection might serve to protect from evaporation as well as attack. They could stand exposure to the air. Some of them might find themselves better off in streams where the water was somewhat too fresh, than in the ocean where the water became too salt. Others would find the reverse. So we find forms diverging, fitting themselves for different stations.

Thus we find in fresh-water forms various concentrations below, in salt water forms, concentrations above, and in land forms the concentrations just about eight parts per thousand.

While Quinton, who first emphasized these facts,[23] considered that concentration the original composition of the ocean, I maintained that it is more likely to be that of the ocean at the close of the Precambrian, *i.e.*, not 2,000 million years ago, but only some 500,000,000. We find the urge to secrete hard parts appears in the same geological period with a simultaneity in various lines of life that points to some changing factor in their common environment as the cause.

The Keweenawan, however, whether Cambrian, as I believe, or Precambian—the current work of Dr. Urry on the helium, radium, thorium ratio of its traps may have settled the question—was at any rate laid down under an oxidizing atmosphere, so that its red sandstones and weathered traps are much like those of later days. It is very different from the Keewatin, and the normal ratio of Na : Cl seems to be not far from this critical value.

When the ocean passed the physiological optimum, some forms were carried passively with it. Others, as has just been said, resisted by secreting shells, by development of a special circulatory fluid and by getting out on land. With the modification of environment came the command, "Modify to match, or migrate, or go to the morgue and mortify!" The annelids and the clam were fitted to stay in the mud, and they stayed. My ancestors "were fitted for higher things," and they migrated to find them.[24]

Various modifications fitted them for various stations in life. But the modification often came first, as assured by the theory of preadaptation of Davenport and Cuénot.

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[21] Yet he found for his Devonian brines the ratio, 0.355. Johns Hopkins University *Contributions to Geol.*, March, 1917, p. 65.

[22] See Howard, *Bul. Am. Ass. Pet. Geologists*, 12, Dec., 1918, p. 1153, and Newcombe, R. B., *Bul. G. S. A.*, 1931, p. 725.

[23] ''L'eau de Mer Milieu Organique.'' *Cf.* ''The Early Surroundings of Life,'' SCIENCE, August 2, 1907. ''Isolation by Choice,'' SCIENCE, May 4, 1906, p. 702.

[24] See also H. Van Dyke's ''Quatrain to a Recreant Clam.''

If so, it is altogether likely that some organisms did not go to or find the place which they fitted.

Only those who had the sense to go to it or, if they were there accidentally, to stay in it would profit by their fitness and variation advantage! If their children inherited their variation and their sense, they would in turn profit by it. Thus a nerve reaction or variation, an intelligence correlative to the other variation was needed.

Some forms would be fitted for land life, could emerge from the sea with a circulation cut off from the sea yet retaining traces of its composition at the time they emerged, and a skin to prevent its evaporation too fast—just enough to keep them cool on hot days. In the new surroundings, which they alone fitted, they would find less competition. If they were eutopotropic, they would stay there and mate with others like-minded.

But once out on land, there is a wide variety of climate—from that of a tropical jungle or of a tropical desert to that of a Siberian desert or to that of the Antarctic continent. Yet almost everywhere we find forms of life, fitted so that they can survive and thrive in those surroundings. Sometimes they have to seek other surroundings to breed.

Now this we notice, that whether or no they fit into their surroundings, the higher life which is mobile does not have to stay there. Indeed, like the migrating bird, it often journeys far. Among the most wonderful journeys are those of the eels, from the center of the Atlantic to the fresh-water streams and back, and the salmon, from the fresh-water streams to the ocean and back.

In other words, with fitting the environment goes finding the environment that fits. Let us illustrate again.[25]

Before the Himalayas were nearly as high as at present, elephants roamed Asia. Some had less hair and were better fitted for the climate of India, others had more and were better fitted for the climate of Siberia. But there was nothing to prevent the hairy one going south. No doubt some did and got too hot and caught cold and died.

Little by little, however, there was a gradual segregation of the hairy to the north, the hairless to the south.

We will agree that there have been great changes of climate. Through these Nature commanded, "Modify or migrate." Some animals, preadapted, could obey the first alternative, others, sensibly eutopotropic, obeyed the second. Those without variability or intelligence perished.

This finding the place for which the organism is fit we call intelligence, or especially when it is hard for us to imagine that in the animal mind the movement is toward a clearly conscious goal, instinct. But in general, the higher animals seem to have instinct replaced more and more by conscious intelligence. Behavior which seems to be controlled by the future, by an aim or goal, we call intelligence, whereas action which we can predict from the past we call mechanical.

"Westward, the star of empire takes its way" describes in poetic language the spread of the race of man over the world after the last ice invasion. It is in part perhaps instinctive. It has culminated in my lifetime in the attainment of the North and South Poles, the battle of Manila, the entrance of Japan into the list of great powers, and the formation of the League of Nations after a world-wide war.

But the settlement of America was partly that of intelligent purpose. My Puritan forebears came with a definite aim, to construct a *commonwealth* (note the word "common") which should be nearer what they thought God wanted, a purer form of government in church and state.

Carl Schurz and the "Lateinsche Bauern" came to get a greater freedom and a more democratic government than then existed in their fatherland. Many before and since have come to America from many lands, the cream of their respective communities, because they were the more discontented and restless, who sought, like Abraham of old, a better land, or as the Pilgrim said, enlargement. These restless energetic souls, even though they may be classed themselves as dangerous radicals, may make fine sires. Many people who would think of Congressman Lindbergh as a dangerous radical would agree that he was a success as a parent, and that the United States stock would not have been improved by keeping him out.

My Uncle Daniel went from New England to Kansas in the days of bleeding Kansas. So his son enlisted in the days of the Spanish War and now finds himself in Honolulu.

In the development of the United States, in the pushing back of the frontier, in the development of the oil business, there has often been little conscious planning for the good of the whole, any more than there was in that wild stampede of individualists which opened the magnificent state of Oklahoma. It was partly "each for himself and the devil take the hindmost" and partly "there is plenty for all, help yourself. Uncle Sam can give every man a farm."

Twenty-odd years ago, called upon to speak at a banquet in Saginaw, about *one o'clock in the morning*, after a long evening of speeches, I told the Saginaw business men that when they ran out of other fuel, they could strike gas! I also told them I hoped they would not strike it before they had changed the state law to prevent overdrilling. They found it where I said, but they had not changed the state law as much as it should be changed, and even since I started writing this, a horrible tragedy of burning, involving some of my friends, has occurred, and may be due partly to overcrowded wells. Overcrowding is emphasized in this year's *Michigan Engineer*.

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[25] *Harvard Alumni Bulletin*, 1925, p. 649; *Tufts College Weekly*, Jan. 1910, p. 175–181.

But, as, when the ocean grew too salt, survival was for those who could find a fit place in new conditions, so it is now. Conditions in America have changed. Our early towns grew helter-skelter. Now we have city-planning boards and the eutopotropic man, if he fits that kind of thing, will seek a decent, a beautiful and a well-laid-out town. No doubt, too, there will be for a good while helltowns, and people who find themselves most at home there will turn that way.

The era of expansion of the human race approaches its close. The era of organization, of cooperation dawns. Not only in the petroleum business, but in world affairs, the question is who has enough sense, enough intelligence to find his place, the place where he fits, and our Nation fits, to find its place in these new conditions.

> The old order changeth, yielding place to new
> And God fulfils himself in many ways
> Lest one good custom should corrupt the world.

We have been absorbing the gold of the world. We have more than half of it. We were gathering in the rest at a rate that would surely corner it. This has not been deliberately and intelligently done, but the result has been one factor in business depression. As we cornered gold, the price of everything else measured in gold went down. If continued, sooner or later debts payable in gold can no longer be paid. Shall we have intelligence to see this and arrange for some way in which the debts due us from Europe shall be paid in some work for world welfare, but not in gold? Shall we have sense enough to fit the new conditions and learn from Him who said, "He that would be greatest among you, let him be the servant of all." Or shall we, buzzing some clichés of isolation and independence and separation of politics and economics, continue to butt our head against the wall, kick against the pricks and squeal when we are hurt?

Years ago I was geologizing down South, and one noon we unhitched the mules from the buckboard and left them to eat their rations of corn from its rear while we sought a cooler spot under the shade of a tree a little out of sight.

After a little the noontide stillness was pierced by a tremendous vociferousness, unquestionably arising from one of the razorbacks. I said to my driver:

"Alex, one of those mules must have kicked a hog."

"Hit sounds lak hit."

The noise continued in undiminished volume. The air quivered.

"It must have broken her leg. Let's go and see."

We went over. The hog had too much sense, was too eutopotropic to get near the business end of the mule, but in reaching through the spokes of the wheel, the spokes caught her by the nape of the neck. As soon as she felt caught, she braced and the more she braced, the tighter she was held. But her vocal powers were not checked at all. We sat and laughed for a while. Then Alex put his foot on her neck. One magnificent squeal and off she trotted, unhurt.

Many animals have no more sense than the hog or the moth with the candle. They will draw tight the cord that holds or chokes them.

When I suggest a tax of two cents a thousand on gas produced, whether used or not, will I not be greeted with squeals of remonstrance as vigorous as that which greeted Doheny's investigation plan? Yet there is that which withholdeth more than is meet, but it tendeth to poverty. Those who protest may be much benefited.

How much better are we?

As geologists we use the present as a key to the past. From past and present we should be more able than many to outline the trend of things. There is the present duty on us to advise and warn our business associates and fellow citizens as to what the experience of the past billion years teaches.

Have we sense enough to fit ourselves to the rôle of a credit nation? Being the richest nation on earth, have we sense enough to know that pride goeth before a fall, or have we sense enough to wisely use our wealth as trustees for the world, in stamping out disease, in preserving ocean life, in studying the climate of the world, in building the beacons of the air, in educating men of science? It would be selfish for this audience to suggest that Germany pay part of her debts by giving scholarships in the advanced work of the universities to 400 of the American geologists out of work, yet it would accomplish a threefold object—not only relieve unemployment, but help Germany's task of paying reparations and improve our geologic skill.

So I do not emphasize this, but I would urge that it is senseless as a nation to shut our eyes and content ourselves with saying, "They borrowed, let them pay," without considering how they are to pay.

I have wondered if the policy of counting every admixture of the white and black races as black, allowing free marriage between black and colored and checking marriage between colored and white (though not entirely preventing breeding) was intelligent and would not inevitably and mathematically lead to a larger and larger preponderance of colored with more or less white blood; whether our attitude toward the Indians (which has led to persons like Mrs. Woodrow Wilson, Calvin Coolidge, Vice-President Curtis, and others) was wiser.

The American people are cramped by legislation and by a respect for tradition in the legal profession, which is not without advantage in retaining what is good from the past, and geologists are evolutionists rather than revolutionists. But it hinders greatly that adaptation to changing conditions which one finds in the frontiersmen.

It made it very hard to change the laws suited for the wet climate and rural conditions of England and the Emerald Isle regarding water rights so as to have a code suited to a land which is worthless without irrigation, or to handle the problems when great cities spend tens of millions and reach out tens of miles to remote watersheds crossing state lines for their water.

The great works of the present, like the Chicago drainage canal, affect men from Georgian Bay on the north side of Lake Huron to New Orleans. They are not state matters.

So again the flood of oil, due to the way in which you petroleum geologists have so successfully, too successfully, applied your science to the development of national resources, can not be handled by individual state action any more than can a Mississippi flood.

In these days of automobiles, to say nothing of airplanes, when in our smaller New England states a man can be in five states in an afternoon, is talk about throwing the control of the liquor traffic back into the hands of the states the buzzing of the June-bug?

Again, facing the problem of unemployment, modified as it is by the enormously increased powers of production, is it not necessary that some planning be done as to what and how much shall be produced? If some new invention puts whole communities out of business through no fault of their own, as the invention of rayon silk has crippled the making of cotton stockings, would it be too much to demand part of the invention royalties to rehabilitate and to teach those thrown out of work some new and useful work?

Should any one out of work be helped until he had been examined for the work to which he is pre-adapted? Possibly he may be out of work because he is no good at the job into which he drifted. Should a prerequisite for a dole be four hours a day of study?

All these are questions which require sound sense, a spirit proposed for progress, but guided by the experience of the past.

Fifty years ago Dr. Penrose and I were in Harvard together. Little did I dream that I should succeed him as president of the Geological Society of America, or that he would leave the society the magnificent endowment that will be a monument to his memory, more enduring than any erected in a cemetery. In the first place, there was no such society. In the second place, he was a freshman when I was a sophomore, and got his bachelor's degree a year later than I, though he received the degree of doctor of philosophy from Harvard two years before me, having the practically unique distinction of obtaining it at Harvard in two years after the A.B.

Now the large endowment brings to the Geological Society new conditions. Shall it be adaptable or eutopotropic? While I do not forget that word of our Saviour, "Where the carcass is there are the buzzards gathered together," I have faith to believe that we have sense enough to be eutopotropic, and will find in these larger conditions room for worthy expansion, that the new conditions may be to us as the expanding shell to Holmes' chambered nautilus:

> Build thee more stately mansions
> Oh, my soul,
> As the swift seasons roll.
> Let each new temple, nobler than the last,
> Shut thee from heaven with a dome more vast.

Environment, heredity—these are not all the factors in evolution. We must add our individuality as helmsman. Some of you have doubtless seen a yacht race. As a son of the Old Bay State, let me close with the following sonnet, dedicated, with his permission, to probably the most skilful helmsman in the United States, Charles Francis Adams—a sonnet which gives a picture of the three factors in evolution. Besides heredity and environment we have individuality—eutopotropism—sense enough to steer a skilful course, sense enough to find the fastest track.

THE RACE

Oh, see the sloops with sails that flash out bright
Against the ruffled sea and grayer sky
Along the horizon, when the waning light
Strikes fairly on the mainsails towering high.
They vanish as they come about to tack—
First one and then another, as for each
The helmsman picks her individual track,
Knowing his own boat's sails and lines and reach.
So, studying wind and wave and rip and tide,
Toward the desired haven they beat in.
Be breeze adverse or light, yet on they glide,
The skipper's wit counts much the race to win.
Our forebears give the boat, but we must steer
Across life's seas, though weather foul or clear.

OBITUARY

GEORGE EASTMAN

THE press and the public seemed instinctively to realize that Mr. Eastman's last message "My work is done; why wait?" and his dramatic termination of his career formed a fitting end to a remarkably consistent life. Certainly it is true that his close friends and associates view this ending as the final triumph of a man who all through life made his own way, made his own decisions and courageously followed the line of his convictions. Consider for a moment the full significance of his last words. He had invented the modern photographic plate; he had invented the photographic film; he had made the kodak a household object throughout the entire world; he had created a great business; he had established a great research laboratory which had strikingly fulfilled his faith in it; he had selected certain fields of education, health and art to which he had devoted his fortune for the benefit of the entire world; he had satisfied his instinctive desires for the excitement of exploration and big game hunting; he had no close relatives; the infirmities of old age had come upon him and were about to master him. He who had always been his own master remained so to the last.

George Eastman was born in Waterville, Oneida County, New York, on July 12, 1854, and lived there until he was six years of age, when his parents, Mr. and Mrs. George W. Eastman, went to Rochester, New York, to live, where in 1842 his father had founded Eastman's Commercial College. The father died two years later, leaving Mrs. Eastman without funds and with the eight-year old boy. By dint of hard work and self-denial Mrs. Eastman kept the boy in school until he was 14, when he became an office boy for Cornelius Waydell, a Rochester insurance agent. He stayed with the firm two years and then went with Buell and Brewster, afterwards Buell and Hayden, insurance agents. He studied at home in the evenings and later became a bookkeeper in the Rochester Savings Bank. It was while he was employed there that he began in his leisure hours experimenting with those photographic developments which were the foundation on which was built the Eastman Kodak Company.

In the very beginning period of Mr. Eastman's experiments, there were boarding with his mother a Colonel and Mrs. Henry A. Strong. Mr. Strong was a well-to-do partner in a whip manufacturing firm. He became interested in Eastman's experiments and his careful calculation as to what might lie ahead in the photographic industry, and in 1881 he made an investment of $1,000 in Mr. Eastman's business, following it shortly afterward with an additional $5,000. For some years Mr. Eastman and Colonel Strong were business associates and together went through some of the early trials and tribulations of the business, for the story of the growth of the Eastman Kodak Company was not without its trials and tribulations, as the following illustration will show.

Late in 1881 or early in the following year, the output of the Eastman plant had risen to about $4,000 worth of plates a month, all of which were shipped to wholesalers, who allowed the unsold plates to accumulate throughout the winter. Suddenly it was found that the Eastman plates had lost their sensitiveness, and complaints began to pour in on the young manufacturer. At great cost he called in and replaced all the defective plates.

Shortly after this episode another calamity came upon the company, for the art of making plates seemed to have been lost. The plates fogged easily and lacked sensitivity. During this period Mr. Eastman slept in the laboratory and carried out 469 experiments, all of them failures, in an endeavor to locate the cause of the trouble. During this time he became so nervous that he could not sleep, and lay awake at night reading cowboy and detective stories in order to rest his mind. Finally, after having been carried into debt, it was discovered that the difficulty was due to a defect in some of the constituents which had been purchased in a large order. Thereafter Mr. Eastman always made careful experiments in order to test new lots of material ordered for his film.

An eager and active research man himself, Mr. Eastman was always on the lookout for new ideas or developments from other sources, and gradually added to his staff young men from all over the United States and England who had shown the ability to contribute new ideas and developments to the photographic art. In this connection, he established his research laboratory, and his vision is shown by the fact that he stated that he did not expect results from it for ten years. His faith, however, has been amply justified by the development of new photographic products. In fact, only a few months ago Mr. Eastman expressed to the director of his research laboratory, Dr. Mees, his feeling of satisfaction in the fundamental strength of the company. He said that never before had such a fine lot of new products been put out and never before had the organization of the company been in so satisfactory a condition. He felt that the future success of the company was assured.

In the recent biography of George Eastman by Carl Ackerman it is stated that by the winter of 1879–1880 Mr. Eastman had established four fundamental business principles upon which he was to build his own company. First, production in large quantities by machinery; second, low prices to increase the usefulness of his products; third, foreign as well as domestic distribution; fourth, extensive advertising as well as selling by demonstration. It was fundamental in his business policy that service should be given to the public. This is illustrated in the watchword in the early days of the kodak: "You press the button; we do the rest." It is illustrated now by the service on film and by the sale of kodaks which, after all, are simply a service and a means to increase the film industry since it is the film and plate industry which is, and always has been, the backbone of the business.

Mr. Eastman has been one of the world's greatest philanthropists. His benefactions during his lifetime exceeded $100,000,000, with $12,500,000 more added in his will. His first contribution to education was made in 1887 when he sent fifty dollars to the Mechanics Institute in Rochester. It was a modest sum, but it was the genesis of his giving. His salary as treasurer of the company was at that time under sixty dollars a week. Even at this early period in his career, he had strong convictions in regard to the relationship of the individual to the community.

By far the largest of Mr. Eastman's contributions have been to the Massachusetts Institute of Technology and to the University of Rochester. He also made important contributions to the Tuskegee and Hampton Institutes for education of the Negroes. He felt a pride in, and a responsibility for, the city of Rochester, and made notable contributions for the benefit of that community, chief of which are the Eastman School of Music and contributions to the medical center of the University of Rochester and the dental clinic. In recent years he had also established dental clinics in several foreign countries. It is said that his interest in so doing was due in part to his desire to make some contribution for the benefit of people in those countries in which the business of the Eastman Kodak Company had prospered in its foreign contacts.

It is very certain that Mr. Eastman's philanthropies were never the result of emotionalism or sudden fancy. They were carefully thought out and calculated. They were generally preceded by a long study of the situation on his part before the recipient had any idea of what was in his mind. They generally came not as the result of a request to Mr. Eastman for assistance, but as the result of Mr. Eastman's own independent study of situations in which he felt that his wealth would be of benefit to the public.

In his first interview with Mr. Eastman thirty years ago, President Rush Rhees, of the University of Rochester, was told by Mr. Eastman: "You know, Mr. Rhees, I am not interested in higher education." At least a part of the story of what caused Mr. Eastman to change his mind on this point and to become one of the greatest of all benefactors of higher education is given in the history of his growing interest in the Massachusetts Institute of Technology.

In 1891 Mr. Eastman asked Professor Thomas M. Drown, of the Massachusetts Institute of Technology, to "select a young chemist from the graduating class who can devote some attention from now until graduation to photographic chemistry. I do not want anyone who is not painstaking, thorough and thoroughly reliable. Harum-scarum youths are not of any account in this business. I have a great deal of confidence in the material you turn out of your institution."

During the next few years Eastman engaged several graduates of the Massachusetts Institute of Technology and his enthusiasm for this "material" increased to such an extent that he began to read the annual reports of President Richard C. Maclaurin and to study that system of technical education. He continued for nearly twenty years to observe the value of technically trained men and posted himself in the history of this institution.

Finally, in 1912, Mr. Eastman expressed a desire to meet the president of the institute, and a meeting was arranged at the Hotel Belmont in New York City. As a result of that meeting Mr. Eastman wrote to the president that he was prepared to give the institute as a building fund the sum of two and one half million dollars, asking that his gift be anonymous, as he wished to avoid all fuss, his one object being to see a good thing done and not to hear people talk about it. In referring to his interview with Mr. Eastman in New York, Dr. Maclaurin wrote: "I could not fail to be impressed with his capacity to go to the heart of a problem quickly and to see immediately what the main points were and to keep to them in later discussions—an impression increased by later intercourse." Later, in 1913, Mr. Eastman increased his subscription to the building fund by five hundred thousand dollars, making his total initial gift three milllion dollars.

For eight years after the initial gift, the name of the donor remained simply "The Mysterious Mr. Smith," and it is possible that it would never have been divulged had not a later gift in 1919, which necessitated the transfer of a large amount of his own Eastman Kodak Company stock, made it inevitable that his connection with the gift would be discovered. Particularly throughout the construction and equipment period of the new technology, but also clear up to the end, Mr. Eastman maintained his very keen interest in the progress of the institution. Yet with all this interest, so far as I know, Mr. Eastman has never visited the institute, except on two or possibly three occasions, and on those occasions he came unrecognized and left unknown except for the president and a very few of his associates. We have here a truly remarkable record. First, a study of the record and work of the M. I. T. for a period of twenty years, then a period of continued contributions to the institute amounting to more than twenty million dollars over a second twenty-year period, and yet during all this time only two or three brief and almost secret visits to the object of his benefactions. And yet this does not mean that he did not pay close attention to the progress of the institution. His letters to President Maclaurin are ample evidence of his very keen insight and sympathy with the educational problem. In my own single visit to Mr. Eastman about a year ago, I was astonished by his keen questions in regard to certain of the funds of the institute and their present utilization.

Mr. Eastman's last gift to the institute was his contribution to the Technology Student Loan Fund. Until last year he had consistently refused to allow his name to appear on the great buildings which his gifts have made possible. The corporation of the institute voted that in recognition of his generosity, the great court about which the main building is built should be designated as Eastman Court. Within the past year Mr. Eastman consented to allow his name to be placed upon the new Physics-Chemistry Research Laboratories, which are therefore to be known as the "George Eastman Research Laboratories."

At various times Mr. Eastman indicated his reasons for giving so generously to the Massachusetts Institute of Technology. To a *Post* reporter he gave the following explanation: "Because Technology has two of the elements necessary for a great educational institution. First, its faculty, and second, the body of students. It lacked only the third great need of a successful educational institution—money. The same money might have been spent to start another school elsewhere, but such a school would lack these necessary elements—faculty and students; and a new school even with money might never have been able to supply them as Technology was and is. For many years I had been coming in contact with men from Technology, many of them right in my own employ here in this company. I'd been watching the progress of Technology for some time—I like to study things—and my special interest in Technology was due, no doubt, to the fact that I was constantly coming in contact with the men who had come from there. I had been watching the treasurer's reports from Tech, too, and so when I came to the conclusion that it was time to help Technology, I asked for an interview with President Maclaurin."

Of the various reasons given by Mr. Eastman for his gift to Technology, three stand out in special prominence:

(1) His appreciation of the needs of technical education of the highest type. He had seen this in his own business and observed it in others and believed that this need would be far greater in the future than in the past.

(2) His belief in the value of scientific training for executives. He knew, of course, that a good executive, like a good poet, is born and not made, but he believed that his training can contribute largely to his effectiveness, and his experience with men that he had employed demonstrated to him that men with a scientific training, and of course the right qualities of temperament and character, make first-class executives.

(3) His recognition of the duty of a man whose business is national to support national institutions and not only local ones.

President Rush Rhees, of the University of Rochester, to which Mr. Eastman's gifts exceed even those to the Massachusetts Institute of Technology, has kindly given me his estimate of outstanding characteristics of Mr. Eastman's philanthropy, based upon close personal relations with Mr. Eastman for a period of more than thirty years. The following paragraphs are quoted from President Rhees's letter:

"The first outstanding characteristic feature of Mr. Eastman's philanthropy, in my opinion, was his accessibility. I believe that beyond any other generous man of wealth, he saw every appeal that came to his office. He maintained no barrier of subordinates through whom alone he could be reached. By this I do not mean that you could walk up to his office and go in. Of course his secretaries protected him, and written appeals would very frequently be routed speedily to a scrap basket, but I believe that all appeals came under his eyes.

"The second characteristic that has impressed me was his independence in reaching decisions on philanthropic projects. Here in Rochester it has for many years been a commonplace remark that if he said with reference to any proposal 'I am not interested,' then that answer was final, nine times out of ten. His independence of mind showed itself, however, in the tenth case, in which, having studied the matter further, he changed his mind, and having changed his mind, would be likely to act with extraordinary broadness of vision. In my first interview with Mr. Eastman, thirty years ago, the remark with which he opened the conversation was 'You know, Mr. Rhees, I am not interested in higher education.' Tech, as well as Rochester, has had very convincing evidence that in that particular he changed his mind, and also, having changed his mind, he proceeded to think of higher education on a scale that fairly astounded its advocates.

"I had another experience of the same sort in 1919 after he had made his initial gift for the School of Music. At that time we undertook to raise a fund of one million dollars to enable us to cancel deficits accumulated during the war period. I went to Mr. Eastman, among others. His first reaction, as firm as it was courteous, was 'I don't expect to give any more money to the University of Rochester.' To which I replied, 'I do not blame you at all; you have done marvelously as it is.' Then we talked over the problem a little further, and he answered, 'Of course I'll chip in,' and gave me one hundred thousand dollars.

"Third: I have referred to the broad scope of his conception of institutions in which he was interested. I remember his telling me with a great deal of pride, on that occasion when he remarked that he did not expect to give Rochester another dollar, that he regarded the Institute of Technology as the greatest educational institution in the world. You know better than anyone else how much he had then done and has since done to insure the realization of that conception.

"Fourth: When he made his great distribution of property in 1924 to you, Hampton, Tuskegee, and to us, I remarked to Mr. Hart, who was in Rochester for the execution of the agreement, 'Did you ever know anyone who "bunched his hits" like Mr. Eastman?' and Hart agreed that he never had.

"This might constitute a fourth characteristic. He did distribute his philanthropies widely, particularly here in Rochester. But he apparently preferred to concentrate his larger interests in a very few places. Relatively speaking, his gifts to Hampton and Tuskegee were phenomenal. I believe that they were due to the confidence inspired in him by Booker Washington, to which confidence Moton succeeded on Washington's death.

"In explaining his very large allocation of the 1924 funds to the University of Rochester, he expressed the conviction that Rochester was all set to become one of the best, though not necessarily one of the largest, universities in the country.

"Fifth: If you have read Ackerman's life of Eastman you must have been impressed with the very early conception of his business enterprise in international terms. I think that he carried over that natural attitude of mind in determining his chief gifts for education.

"Sixth: I would like to supplement what I said above concerning his independence in forming his own decisions by confessing that I take unalloyed delight in a statement which Mr. Eastman made, after the 1924 distribution of his wealth, to a reporter who was interviewing him and asking why he did so much for the University of Rochester. His answer was, 'Mr. Rhees never asked me for a dollar!' I cherish this with delight, because it is not strictly true. I did ask him for money at that first interview when he told me he was not interested in higher education. I also asked him for help at that later time when he told me he never expected to give any more money for Rochester. But these are the only two occasions. The first resulted in a gift of seventy-five thousand dollars; the second, as I have stated, in a gift of one hundred thousand dollars. But, to paraphrase the words of the parable, What are these among so many other millions which have come to our hands?"

Mr. Eastman's feeling of pleasure and satisfaction over his philanthropies is indicated by the following sentence from a letter in which he refers to another educational benefactor: "I think that both he and I have good reason to feel that the money we distributed will produce more important results than if spent in almost any other way."

Mr. Eastman lived quietly alone in the big house on East Avenue, just outside the city proper. It is interesting and pleasant to know, in recalling the self-denials and hardships of his mother during the early years of her son's life, that she also resided in his beautiful home before her death. In fact, he built and furnished the house as a home for his mother. Since 1905 most of his activities radiated from there. Throughout the house are paintings by Millet, Winslow Homer, Corot and others, and for many years his home was open to musicians, artists and sportsmen. In the museum on the third floor are his trophies from Africa, Alaska and other sections. In the spacious conservatory palms and flowers in endless profusion give color and variety to the scene. Here his guests listened to the organ and other music that he provided for the entertainment of his friends, while good-naturedly professing to be a "musical moron." Here his body lay in state preceding the final funeral services.

His death came on March 14, 1932, in the East Avenue mansion. He died as he had lived—thoughtfully, purposefully and with careful attention to details. The world will always hold his memory in warm and admiring regard, and continue to honor the name of George Eastman.

KARL T. COMPTON,
President
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SCIENTIFIC EVENTS

THE COPYRIGHT BILL

The Copyright Bill introduced in the Senate by Senator Hebert, of Rhode Island (S. 176) is substantially the same as the Vestal Bill of 1930–31, which was passed by the House at the last session and was being considered by the Senate in the closing days of the session.

The Copyright Bill favorably reported by the House Committee on Patents April 5, and referred to the Committee of the Whole House on the state of the Union, was introduced on March 10, 1932, as H. R. 10364 and later in amended form as H. R. 10740 and H. R. 10976, by Representative William I. Sirovich, of New York, who, with the shift in control of the House, succeeded the late Mr. Vestal as chairman of the Committee on Patents.

Of the two the House Bill is the better bill. It was drawn from the standpoint of author and artist rather than from that of book and music publisher and distributor; is simpler, more direct, and a better piece of draftsmanship. It makes no reference to the International Copyright Union, but the adoption of the bill would, in the opinion of the State Department, clear the way for ratification of the Rome Convention by the United States, if the Senate were favorable to such action.

It outlaws piracy, recognizes property right as dating automatically from creation of the work or from first public presentation, does not make registration compulsory but encourages registration by restricting the damages that can be secured for infringement of copyright if the work has not been registered; gives the author the right to sell different aspects of his copyright to different parties so that he can dispose separately of publishing rights, dramatic rights, motion picture rights, radio and television rights, etc. The term of copyright is named as fifty-six years from the date of first public presentation.

American authors are still required to have their works printed in America as a condition of copyright.

The bill still favors the corporation over the individual in the vague and doubtful provision that "in the absence of agreement to the contrary where any copyrightable work is created by an employee within the scope of his employment, his employer shall be considered as the author of the work." Whether the writing of a book on physics by a university professor of physics would be "within the scope of his employment" would be for the courts to determine.

The greatest defect in the bill is a provision inherited from preceding bills known as the "book prohibition clause," which in the present bill is camouflaged under a section entitled "Impounding." In the effort to put the purchasing power of the American market into copper-riveted marketable form, so that it can be the subject of contract between American publishers and English authors or publishers, and under the mistaken assumption that additional opportunity for labor is thereby provided for the American workman, the bill prohibits the individual American citizen from ordering a single copy, for his own use and not for sale, direct from London or Edinburgh, Toronto or Sydney, of a book published in English by an author in his own country (even though the American citizen is willing to pay at his own costs the duty imposed on such importation by his own laws), if an American publisher has secured the right to publish an American edition when he is ready to do so, under penalty of impounding at port of entry and eventual confiscation.

As a result of the continued opposition to this provision the grudging concession has been granted that the citizen may exercise his right, provided he has first made application to the holder of the right of American reprint and the American publisher declines, or in ten days fails to signify his willingness, to procure the desired book for the citizen at a time not specified, with no penalty for delay, at a price equivalent to the foreign retail price plus transportation charges and customs duties.

Not 10 per cent. of books in English published abroad are reprinted in this country. The number of individuals who buy books without seeing them and without solicitation, on their own initiative, is relatively small. Yet to put a stop to this negligible trickle of foreign trade which might still flow over tariff walls, it is proposed to destroy a fundamental liberty of the citizen to trade in the markets of the world, so far as reprinted English books are concerned, a restriction on individual liberty for which there is no parallel in the legislation of any country; and for the negligible and doubtful good, thereby to be attained, to subject all legitimate foreign book trade to intolerable red tape and delay. The representative of the Publishers' Association at the public hearing stubbornly opposed the proposal to give the individual scholar the same right that has been finally conceded to libraries and to the United States Government itself, in the case of books for its own use, and the author of the bill at the public hearing, upon conclusion of the reading of a memorandum by Dr. M. Llewellyn Raney against the provision, submitted in writing on behalf of the American Association for the Advancement of Science, made the statement that the provision must remain in the bill because the American Federation of Labor demanded it.

JOHN H. MACCRACKEN
AMERICAN COUNCIL ON EDUCATION,
WASHINGTON, D. C.

PROGRESS IN RESEARCH AT MELLON INSTITUTE DURING 1931–32

ACCORDING to the *Nineteenth Annual Report* of the director, Dr. E. R. Weidlein, to the trustees of Mellon Institute of Industrial Research, Pittsburgh, the sum of $722,541 was received by the institution from industrial fellowship donors during the fiscal year ended February 29, 1932. The total amount of money appropriated by donors to the institute for the past 21 years was $8,277,018, all of which was expended in defraying the cost of scientific investigations conducted for these companies and associations. Throughout the year covered by the report, 75 industrial fellowships, employing 176 investigators and engineers, were in operation. At the close of the year 58 fellowships were active, and of these 28 have been at work for 5 years or longer and 13 have concluded more than 10 years of research.

In reviewing the progress that has been made since 1911, when the industrial fellowship system was established at the University of Pittsburgh, Dr. Weidlein points out that the Mellon Institute has had fellowships on 230 distinct subjects, on which 775 scientists and engineers have been engaged. In all, during the period 1911–1932, 313 fellows and 357 fellowship assistants of the institute have completed their services to science and technology in the institution and have entered the fields of industry and education. As trained additions to the forces of manufacturing and teaching, these men, Dr. Weidlein says, constitute the institute's greatest contribution to humanity.

The fellowship achievements of 1931–32 are summarized in the report, special attention being given to the research advances made by the Air Pollution Investigation, the Multiple Fellowship on By-Product Coke, the Iodine Investigation, the Organic Synthesis Fellowship, the Petroleum Production Fellowship, the Protected Metals Fellowship, the Steel Fellowship, the Sugar Investigation and the Fur Fellowship. The activities of the institute's department of research in pure chemistry are also described.

During the calendar year 1931, members of the institute made the following additions to the literature: 2 books, 4 bulletins, 39 research reports and 33 other papers. Twenty-two U. S. patents and 33 foreign patents were issued to fellows. Lists of publications, 1911–1932, and copies of Dr. Weidlein's report for 1931–32 will be sent free of charge to laboratory directors, librarians and science teachers upon request.

The constructional work on the institute's new building is said to be proceeding satisfactorily; it is thought that this edifice will be completed and ready for occupancy in the summer of 1933.

PRINCETON CHAPTER OF SIGMA XI

THE sixtieth Chapter of Sigma Xi was installed at Princeton on March 19, 1932, and includes faculty members and students of Princeton University and staff members of the Princeton branch of the Rockefeller Institute for Medical Research. Dr. L. B. Wilson, national president, and Professor Edward Ellery, national secretary, were present to conduct the ceremonies. The installation took place in the historic faculty room in Nassau Hall, after which followed a banquet in Procter Hall of the Graduate College.

Twenty-six members of the faculty were initiated to full membership. Fourteen others were elected to membership, but were absent at the time of the initiation. Forty-two Sigma Xi members from other chapters, who are now on the Princeton faculty, affiliated themselves as charter members of the new chapter.

The officers elected for the first year were:

President	G. H. Shull
Vice-President	E. N. Harvey
Secretary	Paul MacClintock
Treasurer	E. R. Caley
Committeeman, 3 years	A. M. Greene, Jr.
Committeeman, 2 years	R. W. Glaser
Committeeman, 1 year	A. F. Buddington

The presidential address by Dr. L. B. Wilson was "The Cultural Implications of Research in the Sciences."

Eight visiting delegates were present as follows:

Chapter	*Delegate*
Brown	Leonard Carmichael
Columbia	J. W. Barker
Lehigh	Gilbert Doane
New York University	H. Austin Taylor
Pennsylvania	Charles W. Burr
Rutgers	M. A. Chrysler
Swarthmore	Edward H. Cox
Yale	L. L. Woodruff

THE OHIO ACADEMY OF SCIENCE

THE Ohio Academy of Science will hold its forty-second annual meeting at the Ohio Wesleyan University, Delaware, on April 28, 29 and 30, under the presidency of Dr. Alpheus W. Smith, of the Ohio State University. The program of the meeting, as now being formed, will follow in a general way those of other years, which is to say, a short business session of the academy will be held early Friday morning followed by a general scientific session to be addressed by distinguished scientists on topics of general interest; the afternoon will be devoted to sectional meetings, seven in all; and Friday evening will be given over to the annual dinner following which the presidential address will be given and possibly other interesting features, including a social acquaintance hour. Saturday will be devoted mainly to an adjourned business session and the completion of the sectional programs and for such diversions, social and otherwise, as may be provided by the local committee, including a trip to the famous Perkins Observatory.

The preparation of the sectional programs is in the hands of the several vice-presidents, as follows:

Zoology, Dwight M. DeLong, the Ohio State University, Columbus.

Botany, Arthur T. Evans, Miami University, Oxford.

Geology, E. M. Spicker, the Ohio State University, Columbus.

Medical Sciences, Shiro Tashiro, University of Cincinnati, Cincinnati.

Psychology, Horace B. English, the Ohio State University, Columbus.

Physical Sciences, Forrest B. Tucker, Oberlin College, Oberlin.

Geography, Eugene Van Cleef, the Ohio State University, Columbus.

It is worthy of note that the last mentioned section, "Geography," is a new section and meeting for the first time with the academy. As the "baby" of the academy it is attracting considerable attention to itself!

The early arrivals on Thursday will find ample provision for their comfort and pleasure in the way of excursions about the city in the afternoon and possibly an informal talk or lecture by some well-known member of the academy or invited guests, followed by a social hour.

The local arrangements are in the hands of the following committee: Claude E. O'Neal, *chairman*, Allen C. Conger, Philip C. Edwards, C. W. Jarvis, Edward L. Rice, William E. Riecken, Lorin A. Thompson, Don B. Watkins and Louis G. Westgate.

WILLIAM H. ALEXANDER
Secretary

SOCIETIES AND SECTIONS MEETING AT THE SYRACUSE MEETING OF THE AMERICAN ASSOCIATION

PLANS are rapidly shaping together for the sectional meetings and those of associated societies for the summer meeting of the American Association for the Advancement of Science to be held in Syracuse from June 20 to 25.

Thus far seventeen organizations have signified their intention of cooperating to make this meeting a successful one. Section A (Mathematics) has plans for at least two sessions. It is expected that each invited speaker will have an hour for discussion on a selected topic. Professor W. A. Hurwitz, of Cornell, and Professor H. N. Gehman, of Buffalo, have accepted invitations to speak.

The American Chemical Society will hold a regional meeting in connection with Section C. A symposium on "The Effect of X-Rays on Biological Life" is planned for Friday morning, June 24. Members of Section B (Physics), Section F (Zoological Sciences) and Section N (Medical Sciences) will undoubtedly participate in this symposium. Friday afternoon and Saturday morning will be devoted to selected papers. The papers on Saturday morning probably will be of greater interest to industrial chemists.

Section E (Geology and Geography) is planning several interesting field trips. It is expected that competent guides will lead these trips and deliver short talks at points of geological interest. The Ecological Society of America will meet with Section F (Zoological Sciences). The zoologists expect to hold programs on Tuesday, Wednesday and Thursday. Several field trips are planned. The section of New York around Syracuse offers exceptional facilities for excursions and field trips for zoologists, botanists and geologists.

Several societies are lending their support to Section G (Botanical Sciences) and their field trips with round table discussions promise to be most interesting. Leaders have been selected for each field trip. Each of these is now busily engaged in working up the discussion material for his meeting. Among the societies and organizations which have thus far promised cooperation in making this an exceptional summer meeting for Section G are: The Botanical Society of America, American Fern Society, Torrey Botanical Club, Syracuse Botanical Club, Geneva Experiment Station, Brooklyn Botanical Garden and the Botanical Department of the New York State College of Agriculture at Cornell.

The psychologists of upper New York will meet with Section I (Psychology) for a two-day program. One symposium will be devoted to industrial psychology and another to mental hygiene. Professor Edward Lee Thorndike will give one of the association's general evening lectures.

Plans have been made for holding at least two symposia in connection with Section K (Social and Economic Sciences); one on "Statistics in Relation to Social Science." The title for the second symposium has not been announced as yet. An excursion to the statistical laboratory of Professor F. A. Pearson and Professor G. F. Warren at Cornell will be a feature of the meeting. The affiliated Econometric Society, an international society for the advancement of economic theory in its relation to statistics and mathematics, will organize at least two symposia. The president, Professor Irving Fisher, will lead a symposium on "Money" and will present a paper. A symposium on "Demand" is also being organized.

Although no affiliated or associated societies are meeting with Section M (Engineering), the section plans two very interesting symposia; one on "Industrial Engineering" and the other on "Aerial Photography."

Every effort is being expended to make the Section N program one of the strongest in years. Several organizations are planning programs either of their own or with Section N. Among those meeting with the section are the Society for Experimental Biology and Medicine (Western New York Branch), Radiological Society of America, the American Society of Bacteriologists (Central New York Branch), Onondaga County Medical Society and the Syracuse Academy of Medicine.

The northeastern section of the American Society of Agronomy is meeting for two days, one at Geneva and one at Cornell. This, in connection with the symposium on "Land Use" to be held at Syracuse will make a very attractive program for Section O (Agriculture).

Several symposia are under way for Section Q (Education). Definite announcements will be made regarding further activities of these sections in the immediate future.

CHARLES F. ROOS,
Permanent Secretary

SCIENTIFIC NOTES AND NEWS

THE sixty-eighth annual meeting of the National Academy of Sciences will be held in Washington on April 25, 26 and 27, 1932.

THE general meeting of the American Philosophical Society, Philadelphia, will be held on April 21, 22 and 23.

THE president of the fourteenth International Congress of Physiology writes that no change has taken place regarding the date fixed for the congress: August 29 to September 3, 1932, in Rome. In the near future members who have already completed and returned their registration cards will receive a second circular giving the latest information regarding the congress, membership card, reduced rate rail tickets and program.

DR. BENJAMIN KENDALL EMERSON, for forty-seven years professor of geology at Amherst College, died on April 7 at the age of eighty-eight years. Dr. Emerson became professor emeritus in 1917.

DR. WILHELM OSTWALD, long professor of physical chemistry at Leipzig, died on April 4, at the age of seventy-eight years.

AT the special convocation of the University of Durham in June next the degree of D.C.L. will be conferred on Sir Frederick Gowland Hopkins, professor of biochemistry in the University of Cambridge and president of the Royal Society.

DR. WILLIAM H. WELCH celebrated his eighty-second birthday on April 8.

DR. WALDEMAR LINDGREN, professor of geology in the Massachusetts Institute of Technology, was recently elected a foreign corresponding member of the Royal Swedish Academy of Sciences and of the Swedish Academy of Engineering Sciences, both of Stockholm.

DR. PHOEBUS A. LEVENE, of the Rockefeller Institute for Medical Research, New York, has been elected a corresponding member of the Bavarian Academy of Sciences.

DR. ALFRED F. HESS, professor of clinical pediatrics in the University and Bellevue Hospital Medical College, New York, has been elected a member of the "Deutsche Akademie der Naturforscher."

THE medal of honor for 1932 of the Institute of Radio Engineers, at its twentieth anniversary convention in Pittsburgh, was presented on April 8 to Past-president Arthur E. Kennelly, professor emeritus of electrical engineering of Harvard University and the Massachusetts Institute of Technology. The citation states that the medal is awarded to Dr. Kennelly "for his studies of radio propagation phenomena and his contributions to the theory and measurement methods in the alternating-current field which now have extensive radio applications."

THE editorial board of *The American Journal of Cancer* gave a dinner at the New York Athletic Club on April 5 in honor of Dr. Joseph Colt Bloodgood, professor of surgical pathology at the Johns Hopkins University and president of the American Association of Cancer Research, on the evening before his departure for a lecture tour in Europe.

DR. ALEXANDER OLIVER RANKINE, professor of physics in the Imperial College of Science and Technology, was elected president of the Physical Society, London, on March 19, at the annual meeting of the society. He succeeds Sir Arthur Eddington, whose name was added to the list of ex-presidential vice-presidents. Mr. T. Smith was elected a vice-president in place of Professor Rankine; the secretaries, foreign secretaries, treasurer and librarian were reelected, and Professors J. A. Crowther, H. R. Robinson and G. F. J. Temple were new members elected to the council.

The coordination of scientific terminology has been considered by a committee which met recently at the International Institute of Intellectual Cooperation, Paris. The committee consisted of Professor Cabrera (Madrid), chairman; Professor Cotton (Paris), representing the International Union of Physics; Professor Willstatter (Munich); Professor Lowry (Cambridge), representing the International Union of Chemistry; Professor Selys-Longchamps and Dr. Ledoux (Brussels), representing the International Union of Biological Sciences, and Professor Lombardi (Rome), representing the International Union of Electrotechnics.

Dr. R. W. Thatcher, president of the Massachusetts State College at Amherst, has resigned owing to ill health, his resignation to take effect next September. After he has had the opportunity for rest he will become, early in 1933, research professor in the experiment station.

Dr. E. K. Marshall, professor of physiology in the School of Medicine of the Johns Hopkins University, has been appointed professor of pharmacology and experimental therapeutics to fill the chair made vacant by the retirement of Dr. John J. Abel.

Due to ill health, Dr. Jacob Diner has retired as the active dean of the College of Pharmacy, Fordham University, but will remain as dean emeritus. Dr. James H. Kidder has been appointed dean.

Dr. Harry B. van Dyke, professor of pharmacology, University of Chicago, has been appointed professor and head of the department of pharmacology at Peiping Union Medical College, Peiping, China, effective about August 1. Dr. van Dyke has been a member of the faculty of the University of Chicago since 1924.

Dr. R. S. Hutton, director of the British Non-Ferrous Metals Research Association, has been appointed the first Goldsmiths professor of metallurgy at the University of Cambridge.

Mr. A. C. Carlton has been appointed curator of geology and the mineral industries of the Museum of Science and Industry of Chicago.

Dr. Helen C. Coombs, of the department of physiology of the New York Homeopathic Medical College, has received a grant of $575 from the Committee on Scientific Research of the American Medical Association for the study of blood changes in experimental epilepsy.

Dr. Wendell C. Bennett, assistant curator of anthropology at the American Museum of Natural History, has arrived in La Paz to undertake a study of the prehistoric ruins at Tiahuanacu and of other Bolivian ruins. Dr. John C. Phillips is collaborating with him.

Mr. S. F. Markham, secretary of the British Museums Association, is traveling in East and South Africa, making a survey of museums.

Dr. Alfred Sturtevant, of the California Institute of Technology, will lecture on genetics and experimental zoology at the University of Birmingham during the autumn term, at the University of Leeds during the second term, and at Armstrong College, University of Durham, Newcastle, during the third term. Dr. Sturtevant is one of two lecturers appointed by the Carnegie Endowment for International Peace to be visiting members of staff in residence at British newer universities for the academic year 1932–33.

Dr. Curt Stern has been appointed visiting professor of biology at Western Reserve University for the coming summer session June 20 to July 29. Dr. Stern will conduct a course on "Recent Advances in Genetics" and one on "The Genetics of Drosophila."

Colonel Charles F. Craig, U. S. Army, retired, professor of tropical medicine and head of the department of tropical medicine at the School of Medicine, Tulane University, New Orleans, gave a Mayo Foundation lecture at the Mayo Clinic, Rochester, Minnesota, on March 29. His subject was "The Amoebiasis Problem."

The annual Sigma Xi lecture at the Kansas State College, Manhattan, was delivered by Dr. Robert Hegner, professor of protozoology in the School of Hygiene and Public Health, the Johns Hopkins University, on April 5. He spoke on "Host-Parasite Relations of Human Protozoa."

Mr. John A. Maloney, assistant to the director of the Museum of Science and Industry, Chicago, gave an illustrated lecture at the University of Illinois College of Medicine on April 6, on "The Museum of Science and Industry."

Dr. M. C. Merrill, chief of publications, U. S. Department of Agriculture, delivered an address on "What Your Government is doing to Enrich Rural Life" before the Brooklyn Institute of Arts and Sciences on April 1.

Dr. Ludwig Pick, honorary professor of pathological anatomy at the University of Berlin, will deliver the seventh Harvey Society Lecture at the New York Academy of Medicine on April 21. His subject will be "Pathological and Clinical Problems in the Study of Osteomalacia."

THE tenth William Thompson Sedgwick Memorial Lecture was given at the Massachusetts Institute of Technology on April 8 by Dr. William G. Savage, county medical officer of health, Somerset, England, on "Some Problems of Salmonella Food Poisoning."

THE first series of the Thomas W. Salmon Memorial Lectures, established in January, 1931, is being given by Dr. Adolf Meyer, Baltimore, on April 8, 15 and 22, at the New York Academy of Medicine on the general subject "Psychobiology." The Salmon Lectures were established in memory of Dr. Thomas W. Salmon, professor of psychiatry at Columbia University College of Physicians and Surgeons and first medical director of the National Committee for Mental Hygiene, who died on August 13, 1927. A fund of $100,000 was subscribed to be administered by the New York Academy of Medicine.

THE Federation of American Societies for Experimental Biology will meet at the University of Pennsylvania, Philadelphia, from April 27 to 30 with headquarters at the Hotel Pennsylvania. On April 27 the members are invited to visit the laboratories of Jefferson Medical School, Hahnemann Medical College, Temple University School of Medicine and Women's Medical College of Pennsylvania. There will also be meetings of the executive committee of the federation and of the councils of the societies. On Thursday, April 28, at 10 A. M. there will be a joint session of the federation, followed by scientific and business sessions of the societies. On Friday, April 29, in addition to the scientific and business sessions of the societies there will be joint demonstrations and at 3:30 P. M. a general meeting of the American Society of Biological Chemists. At 7 P. M. the annual banquet of the federation will be held at the Hotel Pennsylvania. On Saturday, April 30, there will be scientific sessions and a joint session of the federation. Meetings of the following societies will be held, at which members of the federation who wish to attend will be welcome: The American Association of Pathologists and Bacteriologists, the American Association of Immunologists, the American Association for Cancer Research and the International Association of Medical Museums. The meetings of the American Association of Pathologists and Bacteriologists will continue through Thursday and Friday.

THE twenty-fifth annual meeting of the Illinois State Academy of Science will be held on Friday and Saturday, May 6 and 7, at the University of Chicago. The two-day sessions will comprise both general and sectional meetings as well as special inspection trips to the New Oriental Museum at the University of Chicago, the Field Museum of Natural History, the Adler Planetarium and the Shedd Aquarium. The address of the retiring president, Dr. Fay-Cooper Cole, of the University of Chicago, on "The Coming of Man," will be delivered at 7:45 P. M. on Friday, May 6, immediately following the annual dinner of the society, which will take place at the Shoreland Hotel, near the university campus. The meeting will officially begin at 9:30 A. M. on May 6, when Dr. Robert Maynard Hutchins, president of the University of Chicago, will deliver the address of welcome, opening the general sessions at Mandel Hall, to which the public will be admitted. Dr. Cole will respond and will be followed by Dr. M. M. Leighton, chief of the State Geological Survey, who will speak on "Twenty-five Years of the Academy of Science"; other speakers on the general program will be Dr. J Harlen Bretz, of the University of Chicago, whose address will be on "The Glacial History of the Chicago Region," and Dr. L. E. Sawyer, extension forester, of the State Natural History Survey, who will speak on "The National Forest Movement in Illinois."

THE ninth annual meeting of the West Virginia Academy of Science will be held at Concord State Teachers College, Athens, West Virginia, on April 29 and 30. A general session will be held on the morning of April 29, while the afternoon will be devoted to sectional meetings. In the evening an illustrated lecture will be given by the visiting speaker, Professor H. P. Robertson, of Princeton University. Saturday morning, following a brief business meeting, excursions will be made to points of interest in the vicinity of Athens.

THE Louisiana Academy of Sciences held its fifth annual meeting at Centenary College, Shreveport, on April 1 and 2. At the meeting of the academy last year it was voted that a gold medal be awarded for the best paper read before the academy at its annual meetings. This is the first year the medal has been awarded. Professor Hamilton Johnson, of the Louisiana State University, received the award for his paper on "A New Cycle of Operation for Internal Combustion Engines." The next meeting of the academy will be held at the Louisiana Polytechnic Institute at Ruston in the spring of 1933.

THE first and final accounting in the estate of Dr. Richard A. F. Penrose, who died last July, shows a balance for distribution of $8,909,457. The account, filed in the Register of Wills' office, list disbursements aggregating $1,238,057, of which inheritance taxes paid to the Commonwealth of Pennsylvania amount to $903,509. Dr. Penrose's will, after giving $25,000 to his secretary, $85,000 in specific charitable bequests and making other small bequests, left the residue to be divided equally between the American Philosophical Society and the Geological Society of America. Each will receive approximately $4,300,000.

THE condition of the Rockefeller Foundation's offer of $6,000,000 for the construction of a model faculty of medicine in Paris was that a similar sum should be raised in France. It is said that there was every prospect until a few months ago that the necessary contribution would be forthcoming from the French Government in the form of a credit allocated under the national equipment plan voted by Parliament. No such provision was made, however, for the reason that agreement had not been reached on the question of where the proposed laboratory and other new buildings should be constructed.

DISCUSSION

THE FIFTH FLORIDA WHALE SHARK—1932

SINCE the capture of the fourth whale shark at Marathon, Florida, in June, 1923, reports have been coming in of others seen in the Keys and in the Gulf Stream between Miami and the Bahamas. However, all efforts to get definite information about these have been in vain. Recently an 18-foot specimen was taken off Miami and the facts have been gathered to make a new faunal record, the fifth for Florida waters and the seventh for that general locality—the Straits of Florida.

The first news of this fish that reached the American Museum was a telegram which simply read: "Huge shark captured here. Do you want it?" From my personal knowledge of Florida sharks, I judged this shark to be first a great hammerhead (*Sphyrna zygaena*), secondly a huge tiger (*Galeocerdo tigrinus*) and lastly and most improbably a whale shark. Hence I was not very much excited, and when the identity of the shark was ascertained twenty-four hours had passed and it was too late to do anything. However, as will be seen the skin has been preserved and will be mounted.[1]

On January 18, 1932, Captain Thomas Gifford took a party of anglers in his boat out in the Gulf Stream off Miami for a day's fishing. About 2 P. M., while about 30 miles south of the entrance to Miami Harbor, the mate, James O'Neil, saw a large fish, and the vessel's course was set to intersect that of the shark. When the huge fish crossed the vessel's bow it was thought from its color to be a huge leopard or tiger shark (*Galeocerdo tigrinus*). But when Captain Gifford went out to the harpooning "pulpit" on the bowsprit he saw that it was a whale shark (*Rhineodon typus*) with which he and other Florida sailors are somewhat acquainted by reason of various captures of late years in the Florida Keys.

In the excitement over its great size (great in comparison with that of other Florida sharks) and the unusual coloring (vertical yellowish bars separating vertical rows of large yellowish spots), the first throw went wild. The second, however, struck the whale shark in its most vulnerable part—the gill region. The harpoon—one used for striking sailfish—though bent, held, and the fish towed the boat a considerable distance out into the Gulf Stream. Presently, however, it began to weaken from loss of blood and to work toward shore. As it grew weaker, it was drawn up to the boat, lashed fast, and with much resistance was towed into the yacht basin at Miami. Later by means of block and tackle it was swung up clear of the water and photographs were made of it hanging clear.

The fish was harpooned in water about 25 feet deep in the edge of the Gulf Stream, but the capture was made near Beacon O, between Cape Florida and Sand Key, in water between five and ten feet deep. Like other Florida specimens this fish put up no fight other than to tow the boat around in trying to escape. Being of relatively smaller size (18 feet over all) and because of loss of blood by reason of being harpooned in the gills, it offered less resistance than larger specimens harpooned in the back, and was lashed to the boat for towing after about three hours' effort to escape. Three hours more were required to tow it into the yacht basin at Miami, some 25 miles distant.

Mr. Pflueger made a plaster cast of the fish while it was fresh and secured the skin. As noted there were excellent photographs made of the fish swung up by the tail. With the help of these things Mr. Pflueger plans to mount the skin in fashion as near to nature as possible.

The length is variously given as 17 feet, 8 inches, to 18 feet, 6 inches. Various estimates have been made of the weight of the fish, the liver and the heart; but, as they are all merely estimates, they will be disregarded. Mr. Pflueger opened the stomach but found therein nothing but seaweed and a great quantity of partly digested and hence unrecognizable food material.

This is the fifth Florida whale shark and the seventh for this general region—the Straits of Florida. The first specimen (18 feet long) came ashore on Ormond Beach on January 25, 1902. The second (32 feet long) was taken near Knight's Key in May, 1912.

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[1] For the information and for photographs of the fish on which this note is based I am indebted to my friends, Commodore R. M. Munroe of Cocoanut Grove and Mr. John Mills of Miami, and to Mr. Albert Pflueger taxidermist and naturalist of Miami.

The third was 31 feet over all and was captured in the Bay of Florida in June, 1919. The fourth (31.5 feet in length) was harpooned at Marathon in June, 1923. This, the fifth specimen, was taken on January 18, 1932. In addition, two specimens have been captured off Havana Harbor. The first (32 feet long) was taken west of the mouth of the harbor in 1927; the second (about 34 feet in length) was caught east of the harbor mouth in March, 1930. All these fish, save the first, I have put on record but only after the receipt of photographic evidence. Such data have come for this specimen, and since one photograph is the best ever made, I hope later to publish it and others and thus make them available for the use of ichthyologists.

These seven captures in the region of the Straits of Florida indicate that there is a breeding ground somewhere to the southwest from which the fish drift northeast with the Gulf Stream. From various data coming to me over a period of years, I am convinced that this is somewhere in the Yucatan region. The reasons for this are set out in a recent paper of mine,[2] to which the attention of those interested in this particular matter is called.

E. W. GUDGER

AMERICAN MUSEUM OF NATURAL HISTORY

THE WHALE SHARK ON THE COAST OF BORNEO

DARVEL BAY is a large indentation on the northeast coast of British North Borneo. In the jungles behind its flat sandy shore live deer, wild boar, tambadu or huge wild ox, elephant and rhinoceros.

Last summer I discovered that the waters of the bay held monsters even greater than anything on its shores. As the Philippine revenue cutter, *Mindoro*, entered Darvel Bay from the Sulu Sea on August 4, 1931, my friend, the Spanish engineer of the boat, spoke to me of the great "chacon" and its mate which were always seen whenever the *Mindoro* passed that way. To my surprise, while we were talking about it a great whale shark broke water and swam about on the surface, perhaps a little more than two hundred yards away. It was a typical specimen of *Rhineodon typus*, the white spots and longitudinal ridges being more distinct than I had ever seen them before. We estimated the length of the "chacon" to be between 12 and 15 meters.

Our boat was running parallel with the flat sandy coast, and we soon left the great shark behind, as it was merely circling about. Perhaps a quarter of a mile further on another whale shark broke water but did not emerge sufficiently to show its spots. Only its gigantic size, equal to that of the one seen first, told what it was.

The *Mindoro* frequents these waters during several months each year, while watching for smugglers, and anchors not far from the place where we saw the sharks. The engineer told me that he had seen these two sharks almost every time the ship had passed the point during the past fifteen years.

ALBERT W. HERRE,
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DETERMINISM AND THE WEATHER

IN commenting on Professor Compton's[1] remarks on the uncertainty principle and free will, Professor Noyes[2] has contributed to clarity of thought and discussion by pointing out the important distinction between events which are indeterminable and those which are indeterminate. The illustration he has chosen, however, seems to imply a view of causation which calls for a certain amount of comment. He says: "I think no scientific man would claim that because the weather is indeterminable it is indeterminate—that the weather to-morrow will not depend, inevitably, on conditions which exist to-day." On the contrary—be it said for whatever measure of philosophic comfort weather forecasters may derive therefrom—I think that a considerable number of scientific men would decline to commit themselves to any such statement, for excellent reasons which Hume pointed out nearly two centuries ago. Sequence of events, however oft repeated, affords no proof of causal connection. The best that can be said, from the strictly critical standpoint, is that the weather to-day is related to the weather to-morrow through a chain of intermediate unknown events which, if we were able to find them out, we should be likely to naïvely regard as establishing a causal connection.

If it be objected that this strikes at the root of all scientific method, it may reasonably be replied that the scientist should himself be the most eager to examine critically the bases of his own procedure. Such an examination is inevitable when the boundary between physical science and metaphysics becomes as indefinite as it is at the present time.

It may be admitted that there are excellent pragmatic reasons for assuming a causal connection between events or series of events characterized by a high degree of statistical correlation (the relation of the weather on two successive days is not the best example of this!), but it should be pointed out that this assumption does not justify the ordinary idea that the event which precedes in time is the cause, while that which follows is the effect. We are quite as justified in saying that the weather to-morrow is the cause of that to-day as in saying the opposite. Any one to whom the logic of this is not self-evident is invited to reread "Alice in Wonderland, or Through the Looking Glass." When we say that two events are causally related, all that we can mean from either the philosophical or scientific standpoint is that there is a high degree of probability that one will not occur without the other.

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[2] E. W. Gudger, "The Fourth Florida Whale Shark, *Rhineodon typus*, and the American Museum Model Based on It." *Bulletin American Museum of Natural History*, 61: 630–632, 1931.

[1] A. H. Compton, SCIENCE, 74: 172, 1931.

[2] W. A. Noyes, SCIENCE, 74: 595, 1931.

It is a commonplace of probability theory that empirically determined laws are liable to violation. When the probability of such violation is slight, we are prone to disregard it, but on very much the same basis that we disregard the probability of being killed by slipping in the bathtub. This admittedly may happen, but we continue to take baths and hope for the best.

The "collapse of causality" alleged to result from the uncertainties of quantum theory has been variously received by different segments of the scientific world—with alarm and consternation, with resignation or despair, or with an enthusiasm born of the hope that it offers new arguments for human freedom. It is difficult to see how any of these points of view is justified. The principle of causation is just as valid as ever for practical purposes, while from the philosophical standpoint it never had any validity. Therefore it would seem that matters remain *in statu quo.*

If quantum theory has rendered any service to the cause of free will, it is primarily that of showing that some of the reasons for believing in determinism are not as good as was formerly supposed. At present each hypothesis seems to rest on the somewhat precarious ground that the other can not be shown to be true. Without discounting his own prejudices in the matter, the present writer leans to the view that determinism labors under the disadvantage of requiring a greater number of assumptions in regard to the behavior of unknowns. In other words, the conservative attitude is to emphasize that events which are indeterminable are indeterminate as far as we know. It requires an extraordinary extension of the scientific method to assert what would be true if we knew all the facts in the case.

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SEATTLE

ON "ACADEMIC FREEDOM IN ITALY"

IN SCIENCE for March 25 Dr. A. J. Carlson, head of the department of physiology, University of Chicago, asks American biologists not to attend the next International Congress of Physiology, which is scheduled to meet in Rome next August, "unless the brutal and defiant attack on academic freedom on the part of the Italian government is rescinded." The "attack" is the oath of loyalty required by the government from the professors of the Royal universities. I wish to make, in this connection, some statements of facts, which are perhaps not well known, or have often been overlooked in the discussion on the subject.

The Italian universities are classified in three categories, namely, universities entirely supported by the state; universities largely supported by the state and partially by private contributions, and private universities, which do not receive any financial help from the state. The oath is demanded only from the professors (including associates, assistants, etc.) teaching in universities belonging to the two first categories, *i.e.,* from the official instructors maintained by the state. The professors of private universities are, of course, entirely free from such an obligation; a large number of them, however, offered spontaneously to take the oath. As it has been published, twelve, out of a total number of 1,225 professors, refused to take it. Does Dr. Carlson think that the remaining 1,213 took the oath against their conscience? Did he realize that the attitude that he suggested implies an insult toward the very men he seems so anxious to defend?

An oath of loyalty and allegiance to the King, the fatherland and the laws of the state has been required since the time of the constitution of the Kingdom of Italy from every person taking any office in direct dependence on the state. After the advent of the Fascist régime, which represents now the Italian State, the phrase ". . . and to the Fascist régime" was added to the prior formula. The formulae are essentially the same for every category of officials, but may vary somewhat, according to the specific functions which shall be exercised. For the university professors, the sentence concerning their functions is the following: ". . . and (I swear) to exercise the teaching function and to fulfill all academic duties with the purpose of forming citizens active, honest and devoted to the fatherland and to the Fascist régime." The entire formula has already been published in SCIENCE (Jan. 15, p. 73), but evidently in the translation the meaning of the Italian word "probo," *i.e.,* honest, has been confused with "prode," *i.e.,* bold.

The statement of a group of Harvard professors (SCIENCE, *ibid.*), namely, "This decree imposes upon all university professors of the Kingdom of Italy—and among all state officials of the Department of Education it is applicable to university professors alone—the obligation to take an oath which implies complete adherence without reservation or discussion to a particular system of political ideas," is thus somewhat misleading, since all state officials are obliged to take the oath, and not all the university professors.

The Fascist régime, so far as the theory is concerned, undoubtedly is to be considered "a particular system of political ideas," as every other régime in the world. Actually, however, it represents the Italian state as recognized by far the greatest majority of citizens. The state requests its officials, who are supposed to apply its laws and to make the citizens respect them, to take an oath of allegiance, as a means of prevention against the danger of maintaining in dependence on it men whose activity is contrary to the safety of the state itself. This is, I believe, the general procedure in every country. In the United States, for instance, an oath of "true faith and allegiance" to the Constitution, implying the condition to "support and defend the same against all enemies, foreign and domestic," and to be taken "without any mental reservation or purpose of evasion" is required from "any person elected or appointed to any office of honor or profit in either the civil, military or naval service," and, apparently, whatever his personal political ideas may be. Furthermore, examples of states directly defending themselves against professors who are supposed to exercise dangerous political propaganda are very common everywhere, and are well known.

There is not in Italy any limitation whatsoever to discussion and research work in any particular or general biological theory or field; also no restriction from either the civil or ecclesiastical authorities, and this is not the case in every country. Therefore, there is no reason whatever for supposing that a scientific discussion in the field of biology could not enjoy the utmost freedom. A refusal to attend the physiological meeting would only result in a boycott, on the part of American biologists, of the hospitality that the Italian scientists (whose own consciences have allowed them to take the oath) are preparing for their colleagues of the world.

Giuseppe Montalenti
Assistant Professor,
University of Rome
Research Fellow for 1931–32,
University of Chicago

ACADEMIC FREEDOM IN SPAIN

Dr. Carlson's proposal to boycott the International Physiological Congress at Rome as well as Dean Pound's protest to the League of Nations because of the attack on academic freedom in Italy suggests that some similar action be taken by American educators in protesting the much more brutal attack on this same right by the Spanish government in regard to the Jesuit Order. For, whether one agrees with the aims of this teaching body or not, the principle at stake is the same, namely, academic freedom, which has suffered a serious blow not only by the law forbidding members of the Society of Jesus to teach in Spain but by the outright confiscation of their twenty-six colleges serving 14,599 students. Among these institutions were many which were doing notable work in science, especially the Chemical and Biological Institutes of Sarriá (Barcelona) and the Engineering Institute in Madrid.

Particularly obnoxious was the proposal of the government to Father Rodés, director of the Observatory of the Ebro, one of the world's few stations for the study of terrestrial magnetism, to continue his work until they could prepare a staff to replace him and his assistants.

Those who have found fault with Spain because of its backwardness in things scientific will resent this further handicap to progress in science and will add a protest against it to the one against the attack of the Fascist régime on academic freedom in Italy.

Spring Hill College P. H. Yancey, S.J.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR WASHING CORPUSCLES IN SUSPENSION

The original fluid may be replaced and corpuscles washed while still in suspension during centrifugation. This is accomplished by placing the suspension in a conical chamber (A). During centrifugation, the replacement fluid is introduced at the outer and narrow end of the chamber while the replaced fluid is forced out at the inner and wider end. The chamber is so designed that, when properly operated, the rate of flow at the narrow end is too rapid to permit the settling and packing of the corpuscles, while at the wide end it is too slow to carry them out with the replaced fluid. The corpuscles, therefore, remain suspended in the middle of the chamber.

Technique

The conical chambers (A) are filled and inserted in the centrifuge head. These are so designed that all connections are made automatically as they are placed in their guides. An injector tube (G) from an inverted flask (I) containing the replacement solution is clamped in position in the center of the intake chamber (E). The position of the mouth of this tube regulates the height of fluid in the intake chamber.[1] A clamp on the rubber connection (H)

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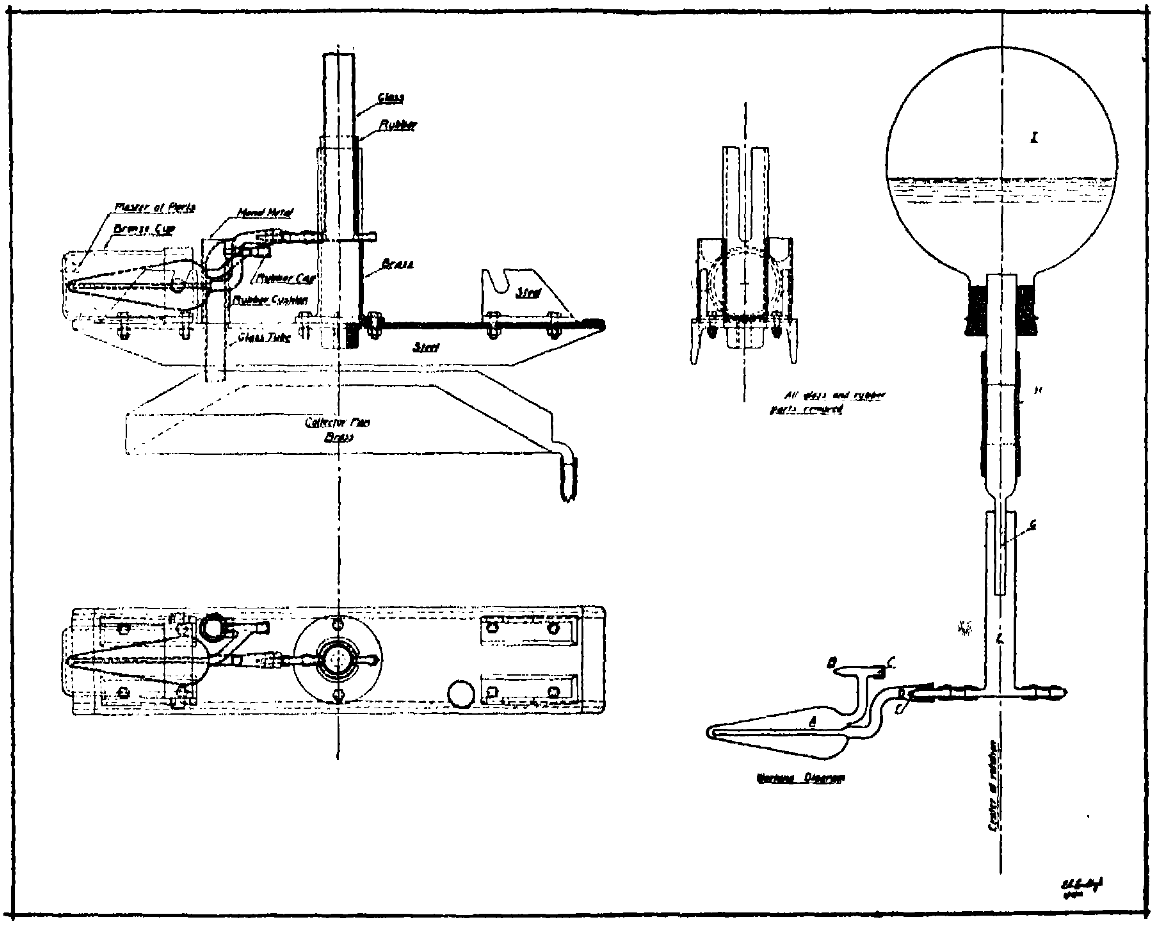
[1] When only one conical chamber is used or when accurate distribution is not essential, the jets (F) may be replaced by full sized glass tubes and the rates of flow of replacement fluid regulated by a jet or valve before it is introduced into the intake chamber. In this case



to the flask (I) prevents the fluid from flowing out. The centrifuge is started and run at full operating speed long enough to permit the corpuscles to settle away from the outlet of the chamber (A). The clamp on the flask connection is then removed and the replacement fluid permitted to flow into the intake chamber. The rate of flow to each conical chamber is regulated by the size of the jets (F) leading to them. The overflow is carried to a collector pan below the centrifuge head. When the desired washing or dilution has been obtained, the flow of replacement fluid is cut off and the centrifuge stopped by applying the brake. The conical chambers are removed from their guides and the suspension of corpuscles may be poured out through the vent tube (C). The corpuscles come in contact with glass only. All vessels and tubes which come in contact with the replacement fluid are glass and their connections rubber.

The rate of replacement and washing depends upon the suspension to be washed and the centrifugal force used. In a first test, a 90 cc solution containing corpuscles in suspension and .02 per cent. phenol red was centrifuged at approximately 650 times gravity at the maximum cross section of the conical chamber. After one minute, the replacement fluid was permitted to flow through the chamber at the rate of 60 cc per minute. At the end of fifteen minutes, the dilution of the indicator showed that only a fraction of 1 per cent. of the original fluid still remained.

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Medical Research

A MODIFICATION OF THE BUCHNER METHOD OF CULTIVATING ANAEROBIC BACTERIA

The apparatus illustrated in the accompanying diagram has been tested thoroughly in connection with our work and has been found very effective for the cultivation of microaerophilic bacteria, at the same time eliminating several of the difficulties involved in using the usual Buchner tube.

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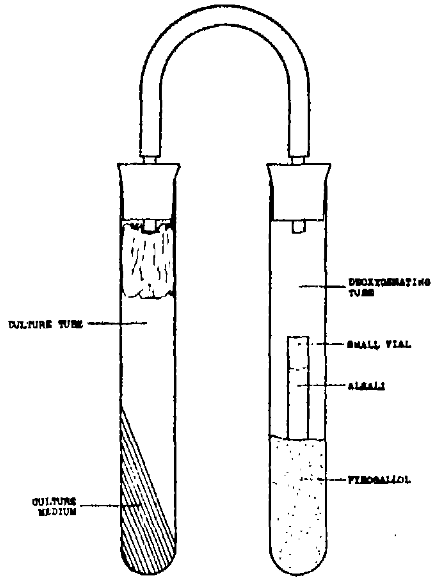
it is convenient to keep the mouth of the injector tube close to the top of the intake chamber. When one of the conical chambers is not in use the jet is replaced with a closed tube and the chamber filled with fluid of proper density to maintain balance.



The diagram is almost self-explanatory. Deoxygenation is obtained by the use of an alkaline solution of pyrogallol. It has been our custom to use enough pyrogallol to form a solid block of about one and one-half inches in a 5 × ⅝ test-tube. The alkali (sodium hydroxide or potassium carbonate) is pipetted into the small vial in the deoxygenating tube and the connections are made as shown. The deoxygenating tube is then tipped to allow the alkali to mix with the pyrogallol. In performing this procedure it is well to have the mouth of the deoxygenating tube low enough to prevent flow of the solution across to the culture tube.

It is possible to open the culture tube several times for examination without renewing the deoxygenating tube by clamping the connecting tube securely. We experimented a number of times with methylene-blue control tubes and found that this procedure could be followed from 4–6 times safely.

Unless the outfit is to be used continuously for more than a week, it is not necessary to seal the connections. When it is desirable to seal the apparatus, collodion is found to be the most suitable material. The collodion should be allowed to dry before deoxygenating the system, otherwise ether fumes may be drawn into the tube, killing the organisms.

A. M. GRIFFIN

BROWN UNIVERSITY

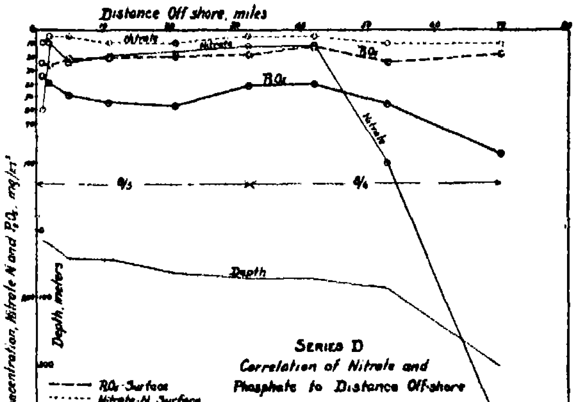
SPECIAL ARTICLES

PHOSPHATE, NITRATE AND NITRITE IN THE SEA-WATER OF REGIONS ADJACENT TO CAPE COD

THE first objective in the chemical program undertaken at the Woods Hole Oceanographic Institution, during the summer of 1931, was a general survey of the waters of the Woods Hole region with respect to their phosphorus and nitrogen content, and especially a comparison of the inshore or neritic waters with the oceanic water found at or near the Continental Slope. The broad shelf to the south of Martha's Vineyard and Nantucket offered a particularly favorable opportunity to study this latter point.

For this purpose two series of stations were established in this area: one, Series D, extending seventy miles to the south of Block Island to the edge of the Continental Shelf, and another Series A, to the south of Martha's Vineyard in a similar manner. Water samples were taken from the surface, bottom and intermediate depths at stations of varying distances from shore. Phosphate, nitrate and nitrite were determined by standard analytical methods.

The samples from Series D were taken on a single trip, covering a total time of less than two days. The results are shown in Fig. 1, correlating the phosphate and nitrate content, both surface and bottom, with the depth of water and distance off-shore. The most significant feature is the increase in phosphate, and more particularly nitrate, found at the bottom as the Continental Slope is approached. The distinction between "oceanic" and inshore water, not only in this series of stations but in others as well, is to be found in the concentrations of phosphate, and more especially nitrate, at the bottom.



The thirteen stations in Series A were visited at various times during the summer, and consequently the results do not represent a continuous profile. They indicate that water movements of a very fundamental sort take place. This is especially noticeable in the vicinity of the slope, where the influence of oceanic water varies over many miles, extending considerably further inshore at some times than at others.

Phosphate and nitrate concentrations at inshore stations, not only in these two series but in others in Vineyard Sound and Buzzards Bay, were found to be variable, even over comparatively short periods of time. This is to be expected from the continuous movements of water due to tidal currents, etc., and is in accord with similar results obtained by the author in the neritic waters of the Gulf of Maine. It is evident that inshore waters can not be distinguished or characterized in terms of their phosphate or nitrate content.

The interpretation of the variations in nitrite is a problem in itself. With a few significant exceptions the following general principles seem to be true: Nitrite is seldom, if ever, found at the surface, and almost always found at the bottom, although there is usually not a very high concentration at the bottom of oceanic stations. It is exceedingly variable from time to time. It is apparently used up by some process at the surface and produced by some process at or near the bottom. This last conclusion is supported by the fact that nitrite-free sea-water inoculated with nitrite-free bottom mud develops nirite on standing.

There were a few cases of exceptionally high nitrite values for which no good reason was apparent, although it may be significant that these came from stations visited earlier in the season than any others.

The source, variations and fate of nitrite will receive intensive study in a future investigation.

NORRIS W. RAKESTRAW

BROWN UNIVERSITY

A METHOD OF IMMUNIZATION WITH CARBOHYDRATE HAPTENS ADSORBED ON COLLODION PARTICLES

To ascertain whether collodion particles combined with haptens induce antibody formation, *i.e.*, whether haptens can be made antigenic by adsorption on nonprotein inert particles I injected 2 rabbits, in 1930, with collodion particles treated with purified type-specific substance of pneumococcus type I.[1] The results were negative. In May, 1931, I started similar experiments with a carbohydrate solution prepared from the anthrax bacillus.[2] Before the immunization experiments were begun I demonstrated that the hapten was adsorbed by collodion particles and that the hapten adsorbed on collodion could not be removed by washing, and was able to react in vitro with its antibody. 0.5 per cent. solution of the hapten was mixed with collodion particles, which, after washing four times, were agglutinated by anthrax-immune serum in dilutions from 1:5 to 1:50. The agglutination was observed best in hanging-drop preparations.

In immunization experiments it was found that when collodion particles are injected into the ear veins of rabbits the Kupffer cells contain collodion particles demonstrable with Ziehl-Neelsen method.[3] These results made it highly probable that carbohydrate haptens adsorbed on collodion particles would induce antibody formation in vivo.

Subsequently and after personal communication Dr. Zozaya reproduced my results. Then we immunized rabbits[4] with the combination of collodion and haptens. Later the work was continued independently.[5]

In one of three rabbits injected with collodion coated with anthrax-carbohydrate the serum gave a faintly positive precipitin reaction with the solution of anthrax-carbohydrate. Rabbits injected with collodion particles coated with the specific substance from pneumococcus type III[6] did not produce agglutinins or precipitins. Work with other haptens and adsorbents is in progress.

JULES FREUND

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BOOKS RECEIVED

AMERICAN MUSEUM EXPLORATION AND RESEARCH: *Sixty-third Annual Report of the Trustees for the Year, 1931.* Pp. v + 205. Illustrated. American Museum of Natural History.

DOLL, EDGAR A., Editor. *Twenty-five Years.* Pp. xxi + 135. Illustrated. The Training School at Vineland, New Jersey.

NATIONAL RESEARCH COUNCIL OF CANADA: *Fourteenth Annual Report.* Pp. 210. The Council, Ottawa, Canada.

NEW YORK STATE HEALTH COMMISSION. *Public Health in New York State.* Pp. 504. Illustrated. Department of Health, Albany.

ROYAL METEOROLOGICAL SOCIETY. *Collected Scientific Papers of William Henry Dines.* Pp. x + 461. Illustrated. The Society, South Kensington, England.

WOODRUFF, LORANDE L. *Animal Biology.* Pp. xii + 513. 297 figures. Macmillan. $3.50.

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[1] The preparation was obtained through the kindness of Dr. M. Heidelberger.

[2] The hapten preparation was given to me at my request by Dr. J. Zozaya, of the H. K. Mulford Co.

[3] J. Freund, *Amer. Rev. Tuberc.*, 12, 124, 1925; J. Freund, *Proc. Soc. Exp. Biol. and Med.*, 28, 65 and 1010, 1930; J. Freund, *J. Exper. Med.*, 55, 18, 1931; S. Mudd, B. Lucke, M. McCutcheon and M. Strumia, *J. Exper. Med.*, 52, 313, 1930.

[4] J. Zozaya, SCIENCE, 74, No. 1915, p. 270, Sept. 11, 1931.

[5] J. Zozaya, *J. Exper. Med.*, 55, 325, 353, 1931.

[6] The hapten preparation was obtained through the kindness of Drs. Avery and Goebel.

SCIENCE

Vol. 75 FRIDAY, APRIL 22, 1932 No. 1947

Statistical Mechanics and the Second Law of Thermodynamics: Dr. P. W. Bridgman 419

Obituary:

Charles Sheldon Hastings: Professor Frederick E. Beach. *Recent Deaths* 428

Scientific Events:

A New Tuberculosis Building at the Pasteur Institute; The X-ray Unit of the Hospital of the University of Michigan; Exhibit of the Philadelphia Mineralogical Society; The American Medical Association; Fellowship Awards in the Sciences at Yale University 430

Scientific Notes and News 433

Discussion:

The Analysis of Electromyograms: Dr. H. Davis, Dr. A. Forbes and L. Garceau. *The Pine Forests of Costa Rica:* Paul C. Standley. *The Soaring of Turkey Buzzards:* Professor G. S. Dodds. *On the Early History of Platinum:* E. P. C. Meyer 436

Reports:

The Incorporation of Scientific Societies: Dr. Burton E. Livingston, Professor James B. Overton and Dr. Walter Thomas 438

Scientific Apparatus and Laboratory Methods:

Apparatus for Determination of CO_2 and O_2 of Respiration: Dr. M. H. Haller and Dr. D. H. Rose. *Vegetable Peptone Agars for Quantitative Work with Lactobacillus Acidophilus:* Dr. Freda M. Bachmann and Professor W. D. Frost 439

Special Articles:

Cure of the Cachexia Following Hypophysectomy by Administration of the Growth Hormone: Professor Herbert M. Evans, Professor Karl F. Meyer, Richard Pencharz and Dr. Miriam E. Simpson. *The Transformation of Serum Albumin into Serum Globulins:* A. Fischer. *Periodical Properties of Atomic Nuclei:* G. I. Pokrowski 442

Science News 8

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STATISTICAL MECHANICS AND THE SECOND LAW OF THERMODYNAMICS[1]

By Dr. P. W. BRIDGMAN

HARVARD UNIVERSITY

One thing that has much impressed me in recent conversations with physicists, particularly those of the younger generation, is the frequency of the conviction that it may be possible some day to construct a machine which shall violate the second law of thermodynamics on a scale large enough to be commercially profitable. This constitutes a striking reversal of the attitude of the founders of thermodynamics, Kelvin and Clausius, who postulated the impossibility of perpetual motion of the second kind as a generalization from the uniformly unsuccessful attempts of the entire human race to realize it. Paradoxically, one very important factor in bringing about this change in attitude is the feeling of better understanding of the second law which the present generation enjoys, and which is largely due to the universal acceptance of the explanation of the second law in statistical terms, for which Gibbs was in so large a degree responsible. Statistical mechanics reduces the second law from a law of ostensibly absolute validity to a statement about high probabilities, leaving open the possibility that once in a great while there may be important violations. Doubtless another most important factor in present scepticism as to the ultimate commercial validity of the second law is the discovery of the importance in many physical phenomena of those fluctuation effects which are demanded by statistical mechanics. It is very hard indeed for one who has witnessed the Brownian motion for the first time to resist the conviction that an ingenious enough engineer might get something useful out of it, and I have no doubt that many in this audience have tried their own hand at designing such a device, and I also have no doubt that their success has been discouragingly nil.

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[1] The Ninth Josiah Willard Gibbs Lecture, delivered at New Orleans, December 29, 1931, under the auspices of the American Mathematical Society, at a joint meeting of the society with the American Physical Society, and Section A of the American Association for the Advancement of Science.

There are other aspects also of the statistical point of view which have become prominent in the last few years, as, for example, the speculations of Eddington on time's arrow and on the meaning of time in general, the speculations of Lewis as to completely reversible time, all the recent concern and new notions about the destiny of the universe as a whole, in which thermodynamic arguments play a most important part, and it is of course notorious that the notions of probability, which are fundamental in statistics, are at the very bottom of wave mechanics.

It is evident, therefore, that the statistical point of view entails consequences important both conceptually and practically. In the hope of helping a little to a better understanding of the situation I propose to-day to examine a few of the implications and consequences of the statistical point of view. The program is a very modest one, and I hope you will have no expectation of a final solution of any of these difficult questions; my primary purpose is to awaken a more vivid self-consciousness of what the situation actually is. I shall be mostly concerned with the classical statistics, and shall have less to say about questions raised by wave mechanics; we shall find that the questions raised by the classical point of view are sufficiently fundamental. I shall throughout adopt the point of view that I have called *operational,* that is, I shall seek the meaning of our statements and concepts by trying to analyze what it is that we do when we are confronted with any concrete physical situation to which we attempt to apply the concept or about which we make the statement.

It is in the first place most important to realize that the statistical method, in which the notions of probability are fundamental, has, when applied to the understanding of physical situations, certain inherent, unique, logical characteristics, so that any account which statistics can give of physical phenomena must have an entirely different aspect from that of such a method of approach as classical mechanics, for example. The reason for this is that probability is not a notion which can be applied to concrete individual events, whereas we demand that we understand, or predict, or control, the individual event. I demand to know what will happen when I throw this particular stone in the air, or explode this particular charge in the cylinder of a gas engine. Ordinary mechanics gives an unequivocal answer, and in general the explanations of ordinary mechanics make direct contact with just such concrete individual physical events. But the notions of probability have no such application to individual events, and in fact the notion of probability is meaningless when applied to an individual event. The proof of this is given by mere observation of what we do in applying the notion of probability. Suppose that I show you a die and remark that I intend to throw it in a minute. You volunteer the information that the probability is one sixth that the throw will be a six. I am skeptical and ask you to justify your statement by pointing out the property of the event, when it takes place, that can be described as a probability of one sixth for a six. I then make the throw and get a six. What possible characteristic has this single event that can justify your statement? Your statement has immediate meaning only when applied to a long sequence of events, or when applied to the *construction* of the die and the method of throwing it. Even when applied to a sequence of events there is always an unbridgeable logical chasm thwarting a precise application of the notion of probability to any actual sequence. Consider, for example, the classical example of tossing a coin. In practice our first concern is to determine whether the coin is a fair coin, that is, whether it is equally likely that heads or tails appear. Suppose that we make a million throws, and find the excess of one or the other not to be more than 1,000. Then we are likely to say that the coin is fair. But, logically, we are bound to recognize that the coin may have been loaded so that heads were, perhaps, nine times as likely to appear as tails, only that we had happened on one of those excessively rare sequences in which as many tails appeared as heads. Rigorously, there can be no method by which we can be sure that all our past experience has not been one of these excessively rare sequences which logically we are bound to recognize as possible in any statistical assembly.

Passing over these logical difficulties in applying precisely the notions of probability to any actual physical situation, it is evident, I think, that, when applied to individual events, probability can have only a secondary or derived meaning. I believe that an examination, as the operational point of view prescribes, of what one does, will show that the meaning to be ascribed to the probability of individual happenings is to be found in the rules of the *mental* game that one plays in thinking about and trying to understand the individual events. This has important consequences when we attempt to use the notions of probability in building physical theories. We must recognize in the first place that any physical theory demands the construction of some sort of model. Now any model involving notions of probability is of necessity more remote from the physical situation and more esoteric in character than the more usual and naïve models, such as are offered by ordinary mechanics. For any statistical model involves conventionalized events to which the notions of probability are by definition applicable, although the notion of probability does not apply at all to the concrete physical events which are the counterpart of the events of the model. It is therefore not surprising that the connection between the properties of the statistical model and the corresponding physical system is somewhat different from the connection in the more ordinary sorts of model.

It would be possible to digress considerably here to discuss the properties which we demand in our models, and the uses to which we put them. The subject is fairly obvious, however, and I believe we can safely assume an understanding of the essential features. The least exacting demand that we make of a model is that it serve as a calculating device, by which we can predict actual physical happenings, and for this purpose any sort of consistent correspondence between the model and the physical happening is satisfactory. The simplest way in which the statistical model can satisfy this simplest and minimum demand is evidently that actual happenings in the physical system shall correspond to high probabilities in the statistical model. This furthermore seems to be the only possibility and all that we can do; in the model there are no certainties, only probabilities, some of which, it is true, may be very close to unity, whereas in the physical system there are invariable happenings, as for example, a cake of ice always melts when it is heated above the melting point, or the external atmosphere always rushes into an exhausted electric light bulb when it is cracked. On the other hand, it is most natural to say that low probabilities in the model correspond to infrequent occurrences in the physical system. But to go further and specify exactly how close to unity we shall demand that the probability be that is to correspond to an invariable happening, is not so easy, and there seems to be a certain unavoidable fuzziness here defeating every endeavor to make sharp connection between the model and actuality. There is a still greater difficulty in giving a precise physical significance to events in the model of low probability; we shall return to this question. For the present the important point for us is that any statistical model is in peculiar degree purely a paper and pencil model, and peculiar limitations may be expected in the use of such a model.

If the only demand that we put on the model were that it should serve as a computing device, the situation would be comparatively simple and could be quickly dismissed. But as a matter of fact we make the more exacting demand that the model enable us to understand the physical situation, and to this end we demand that there be a further correspondence between the properties of the model and of the physical system. Since we do not usually make the extreme demand that the model enable us to understand all the physical properties of the system at once, we usually do not demand that there be an exhaustive correspondence between the properties of the physical system and those of the model, but we are satisfied with a correspondence of those properties only which are pertinent for our immediate purposes. Thus for the discussion of the thermodynamic properties of a perfect gas, a model is usually sufficient in which the molecules of the actual gas are replaced by perfectly elastic spheres or ellipsoids, although such a model gives no hint of the optical properties of the actual gas. It is curious, however, that even for thermodynamic purposes we would not be satisfied with a model in which the number of fictitious molecules is not equal to the number of actual molecules which various other sorts of physical evidence lead us to ascribe to the actual gas.

If, now, we are attempting to find a model for the thermodynamic properties of a gas, we see that the accepted models which satisfy these additional requirements go far beyond the original demands, for in such models we encounter all the phenomena of fluctuations. Strictly, such a model never comes to equilibrium, and can not therefore possess any property which strictly corresponds to temperature as defined classically in terms of equilibrium states. The remarkable fact, of course, is that the fluctuations of the model were found to correspond to fluctuations in the physical system, as shown by the Brownian motion, and in consequence we have now come to recognize that temperature is physically only an approximate concept, instead of the exact concept originally assumed in thermodynamics. This gives us at once one possible method of dealing with the second law and its apparent violations. If we choose to formulate the second law by the statement that dQ/T is an exact differential, then by its very form it applies only to those situations to which the temperature concept applies, and since the temperature concept never exactly applies to any physical situation, we are left with a law which may be rigorously exact in the limit, but which applies to no actual situation. This method of meeting the situation may perhaps be satisfactory to the pure logician, but to the individual interested in filling his pockets by bootlegging entropy, such considerations will appear as uninteresting and as ineffectively legalistic as the restrictions which the more ordinary sort of bootlegger fails to recognize.

It is probably not possible to set up a mechanistic model of a purely thermodynamic system, for the thermodynamic system knows no details, but only pressure and volume and temperature, whereas it is the essence of a mechanical model that it contain details which can have no counterpart in the physical system in so far as it is purely thermodynamic. This prepares us to recognize that the concepts of thermodynamics have no absolute validity, but are relative to the operations, and in particlar to the scale of the operations which we use. Thus a fluid in turbulent motion may have a temperature from the point of view of a thermometer with a bulb several centimeters in diameter, but may have no temperature from the point of view of a minute thermo-couple such as biologists have recently used in probing the interior of single cells. Or again, the entire body of phenomena to which the so-called third law is applicable would immediately appear in a different aspect and the third law would no longer be applicable if the operation of taking atoms apart and recombining them was added to the other permissible operations of a more conventional character. In recent papers Dr. David Watson has discussed some of the consequences of a recognition of some of the other relativistic characteristics of the entropy concept.

There seem to be two diametrically opposite and equally natural reactions to an appreciation of this situation. The first reaction is that of the younger generation, part of which, at least, expects to discover some day in the realm of microscopic operations the possibility of a profitable entropy bootlegging business, and there is, secondly, the reaction of the other school, which is convinced that the second law involves something absolutely fundamental, and that any formulation in terms involving relative magnitudes or permissible operations can be only an incomplete formulation.

In the endeavor of the second school to find a more fundamental formulation it is natural to attempt to capitalize the striking success that the statistical point of view has already had in dealing with the phenomena of fluctuations. One recent and well-known attempt in this direction is that of Eddington to appraise the second law in terms of what is essentially a shuffling process. Eddington sees in the universal tendency for entropy to increase, or for a system to pass from a less to a more probable configuration, the analog of what happens when a pack of cards is shuffled. Now although there may be strong points of analogy between these two processes, it seems to me that there are also essential differences, and that the analogy on the whole is not a happy one. Shuffling acquires meaning only when we are able to apprehend the cards as individuals by marking them so that we can identify them as individuals, but in such a way that there shall be absolutely no effect on the shuffling process. The picture that Eddington had in mind was a pack of cards freshly received from the manufacturer, arranged in suits and by rank in the suits, and then shuffled and losing all trace of its original arrangement. But, as G. N. Lewis has remarked, the arrangement of the cards in suits is one of entirely arbitrary significance; from the point of view of some other game than whist the initial arrangement was already a completely shuffled arrangement as well as all the subsequent ones. Or we may look at it in another way. Imagine an infinite sequence of deals, the cards being partially shuffled between each deal, and suppose that a complete record is kept of all the hands. Somewhere in this sequence there will be deals in which the cards are distributed among the hands by suit and the arrangement in each hand is by rank. If one examines the record it will be found that as one proceeds away from the exceptional deal, both forward and backward in the sequence, all trace of the regular arrangement becomes obliterated. That is, shuffling with respect to any configuration selected arbitrarily as of special significance is symmetrical with respect to past and future time, and the analogy with the thermodynamic situation disappears. There are other difficulties with the shuffling point of view. We have seen that shuffling has meaning only when the cards can be identified as individuals. But if the cards can be handled as individuals, they can be unshuffled, as any whist player will demonstrate to you within five seconds of picking up his hand. To see in the shuffling process something analogous to the inexorableness of the increase of entropy in nature involves the thesis that, although it may be possible to identify the elements in a physical situation, there is some restriction in nature which prevents us from treating these elements separately and sorting them out. This, it seems to me, is a hard doctrine. There is no suggestion of such a state of affairs in any picture offered by the classical mechanics, and classical mechanics was all that Eddington had in mind. Until the reason is elucidated for this surprising inability of ours to handle what we can see, I believe that the shuffling analogy must be judged only to obscure the situation rather than to clarify it.

At first glance, the possibility of understanding the strange restriction against touching what we can see is even more remote from the wave mechanics point of view than from the classical, for seeing is now to be considered as a kind of touching, namely, touching with a photon. It may well be, however, that we have here the key to the ultimate solution, for it is not sufficient merely to touch, but the touch must also control; such a kind of touch doubtless requires the cooperation of a great many photons, and thus will be less possible of attainment than the touch by a single photon which is sufficient for recognition. But this point of view we do not follow further here.

Not only does Eddington see in shuffling the complete analogy of the inexorable increase of entropy, but he sees something even more fundamental, namely, an explanation of the properties of time itself, and in particular why it is that time is unsymmetrical and flows only forward. This he has expressed by saying that the increase of entropy of the universe is what it is that gives direction to time's arrow. This conception deals with such fundamental matters and has been hailed in so many quarters as being of such unique profundity, that we may be pardoned for stopping for an examination of what is involved. Eddington sees the crux of the matter in an essential difference between the equations of ordinary mechanics, including electrodynamics, and thermodynamics. The equations of ordinary mechanics and of electrodynamics, which express what Eddington calls primary law, are of such a character that the differential of time may be reversed in sign with no change in the equations, as, for example, in the equation for a falling body, $d^2s/dt^2 = -g$. It is evident enough that the equation is unaltered if the sign of dt is changed; the question is what is the significance of this observation? The significance that Eddington ascribes to it is that the equation is unaffected by a reversal of the direction of flow of time, which would mean that the corresponding physical occurrence is the same whether time flows forward or backward, and his thesis is that in general there is nothing in ordinary mechanical occurrences to indicate whether time is flowing forward or backward. In thermodynamic systems, on the other hand, in which entropy increases with time, time enters the differential equation as the first derivative, so that the direction of flow of time can not be changed without changing the equation. This is taken to indicate that in a thermodynamic system time must flow forward, while it might flow backward in a mechanical system.

As thus expressed there seems to be considerable vagueness about some of the ideas; this vagueness I find in Eddington's original formulation. Such vagueness is natural and perhaps inevitable in a popular exposition, but if we are to understand from the operational point of view what is involved here, we must try to be more precise. Careful analysis has not yielded to me more than the following as an exact statement of what is involved. Imagine a closed system, and an assistant with a note book in which at a given instant of time he notes all the data necessary to characterize completely the configuration of the system. At a later instant of time he records the corresponding data in another note book. He then gives us the note books and we try from a study of them to determine which set of data was recorded at the earlier instant of time. If the system was a thermodynamic system we can make the decision, because the entropy increases with time, but if the system was a mechanical system we can not decide which note book was used first, because examples could be set up for either one or the other. Eddington expresses this difference by saying that the direction of flow of time has no significance in the mechanical system.

It is, of course, true that the differential equation of the mechanical system is differently constructed from that of the thermodynamic system, but the significance of the difference does not need to be formulated as does Eddington. We must in the first place remember that the equation of the mechanical system, for example, $d^2s/dt^2 = -g$, applies not only to a single system—that is, to a single falling body—but applies as well to a family of systems. The equation has the property that, corresponding to every specific system, with its particle at a definite point moving with a definite velocity at a definite instant of time, another system is possible with its particle in the same position at the same instant, but with a negative velocity. This is because the equation is of the second order, and gives on integration two constants, which may be so adjusted as to give any position and any velocity at any instant of time. Imagine the second system set up; as time goes on it will trace out in reverse sequence the positions of the first system, as may be seen from the equation itself, which may be written

$$\frac{d^2s}{dt^2} = \frac{dv}{dt} = \frac{d(-v)}{d(-t)} = -g.$$

It is this fact which makes it impossible to decide, in our example above, which note book was used first, because there is no way of telling from the entries alone whether they applied to the first or the second system. But in no case is there any question of time flowing backward, and in fact the concept of a backward flow of time seems absolutely meaningless. For how would one go to work in any concrete case to decide whether time were flowing forward or backward? If it were found that the entropy of the universe were decreasing, would one say that time was flowing backward, or would one say that it was a law of nature that entropy decreases with time? It seems to me that in any operational view of the meaning of natural concepts the notion of time must be used as a primitive concept, which can not be analyzed, and which can only be accepted, so that it is meaningless to speak of a reversal of the direction of time. I see no way of formulating the underlying operations without assuming as understood the notion of earlier or later in time.

Lewis, in a recent paper, "The Symmetry of Time in Physics," adopts a point of view in some respects similar to that of Eddington, although Lewis would certainly disclaim more than very partial agreement with Eddington. Lewis speculates about the fundamental significance of the symmetry of time in physics. His point of view takes its origin from the four-dimensional representation of events employed in relativity theory, and the consequent reduction of all propositions in kinematics to propositions in four-dimensional geometry, rather than from the form of the equations of mechanics, as in Eddington's theory. But both neglect what I believe to be the most important aspect of the situation. Both the equations giving the motion of the system and the four-dimensional representation of the motion are only a small part of the story. The equations are without significance unless the physical operations are also defined by which numerical values are assigned to the various symbols of the equations. For instance, in treating a falling body, we need in addition to the equation itself a set of directions for the use of the equation, in which it is set forth, among other things, that s is the number obtained by making with a meter stick certain manipulations connected with an arbitrary origin and the instantaneous position of the falling body. Similarly, in the four-dimensional representation, we must know the physical operations by which the numerical values of the coordinates are obtained which go into the four-dimensional diagram. If one examines the operations by which meaning is given to the symbols which occur in the equations or to the coordinates in the geometrical representation it will be found that the time concept has to be assumed as primitive and unanalyzable, for the operations essentially assume that the operator understands the meaning of later and earlier in time. For example, in order to find the velocity of a particle, one has to observe its position at some one instant of time and combine with this in a prescribed way the result of another observation at a later instant. If one does not intuitively understand what is meant by a later instant, there is no method of formulating the operations. The same situation is involved in specifying a thermodynamic system. One of the variables is the temperature; it is not sufficient merely to read at a given instant of time an instrument called a thermometer, but there are various precautions to be observed in the use of a thermometer, the most important of which is that one must be sure that the thermometer has come to equilibrium with its surroundings and so records the true temperature. In order to establish this, one has to observe how the readings of the thermometer change as time increases.

This point of view, that the schedule of operations by which the symbols acquire meaning is as important a part of the physical situation as the relations which are found to hold between the symbols themselves, has an important bearing on a very widely spread tendency in modern physics and science in general to see nothing as significant except the relations, and so to reduce all science to a kind of topology. It is this point of view that is at the bottom of Einstein's philosophy when he says, for example, that all that is observed is a series of space-time coincidences, and which Eddington expresses by saying that nature may be reduced to a series of pointer readings. If one grants that the ultimate object of physics is to establish a certain sort of relation between us and the world of our senses, to speak with a certain monstrous naïveté, I do not see how it is possible to discard as irrelevant the fact, for example, that the fourth coordinate in the four-dimensional geometry of relativity has to be obtained by an entirely different sort of operation from the other three coordinates, or to regard the entire situation as exhaustively characterized by the relations between the numbers, irrespective of how they are obtained.

We return now to a further consideration of our statistical model and the methods by which we shall establish a correspondence between its properties and those of the physical system. Hitherto we have been gratifyingly successful; events in the model of overwhelmingly high probability correspond to invariable happenings in the physical system, and less common events in the model, such as fluctuation phenomena, are found to be prophetic of a previously unsuspected new domain of physical effects, typified by the Brownian motion. Encouraged by this success, it is natural to think that we have got hold of something real, whatever that may mean, and to push our scheme of correlation to the logical limit, and say that all the excessively rare events corresponding to low probabilities in the statistical model are correlated with corresponding rare events in the physical system. Now it is a consequence of the fundamental assumptions which have gone into the usual statistical model, namely, that all elementary configurations are entirely independent of each other, so that the probability of any configuration is to be calculated by purely combinatorial methods from the relative number of ways in which the configuration can be realized, that there is some chance of the occurrence of any configuration, no matter how unusual its properties. This would mean that in the corresponding physical system any configuration whatever, compatible with the fixed conditions, would occur occasionally, as, for example, the gas in a box will occasionally automatically all collect itself into one end. This conclusion is indeed taken literally by many experts in statistical mechanics, and in the literature statements are not uncommon, such, for example, as that of Bertrand Russell in a recent magazine article that if we put a pail of water on the fire and watch it for an indefinite time, we shall eventually be rewarded by seeing it freeze. It seems to me that there are a couple of objctions that can be made to the conventional treatment of rare occurrences, which I shall now examine.

The first difficulty is with the technical method of calculating the chances of observing a rare configuration, and is concerned only with the model itself, and not with the physical application of the results of the calculations. In computing the chance of any configuration, it is always assumed that the elements of the statistical model are without influence on each other, so that the chance of a given configuration is given by merely enumerating the number of complexions corresponding to the given configuration. For example, in the kinetic theory of gases it is assumed that the location of any molecule and its velocity is, except for the restriction on the total energy and the total volume, independent of the location or the velocity of any or all of the other molecules. It may be proper enough to postulate this for the model, but we know that it can not rigorously correspond to the physical system, for the molecules of a gas do interact with each other, as shown by the mere fact that they conserve their total energy, and the transmission of energy from one molecule to another takes place only at a finite rate, so that if, for example, at one instant all the velocity were in a single molecule, we would find that immediately afterward only molecules in the immediate vicinity had any velocity. This means that the assumption of complete independence must be recognized to be only an approximation, and some way of handling this approximation must be devised. The method usually adopted is to cast the problem in the form of inquiring how many observations must be made in order that the chance of observing the desired rare configuration may be one half, for example, choosing the time between observations so long that at each observation all appreciable trace of the previous configuration shall have been obliterated, so that the assumption of independence may apply. The point now is this: the time that one has to wait for the probable obliteration of all traces of a previous configuration becomes longer the rarer the previous configuration; obviously it takes longer for a gas to efface all trace of having been all concentrated in one half of its available volume than to efface the traces of a small local concentration. The situation is, therefore, that not only must we make an increasingly large number of observations in order to hope to witness a rare configuration, but the interval between our observations must also get longer. It is merely the first factor which is usually considered; when both factors are considered it is not at all obvious that the process is even convergent. This point should be subjected to further examination.

There is another difficulty connected with the mere calculation of the probability of rare occurrences presented by quantum theory. All classical calculations assume that the molecules have identity. But the uncertainty principle sets a limit to the physical meaning of identity. It is not possible to observe the position and velocity of any molecule with unlimited precision, but there is a mutual restriction. After an observation has been made, the domain of uncertainty in which the molecule is located expands as time goes on. If the domains of uncertainty of two molecules overlap, then the identity of the molecules is lost, and a subsequent observation will not be competent to decide which molecule is which. The only way of maintaining the identity of the molecules is by making observations at intervals so frequent that the domains of uncertainty have not had time to overlap. But this time is obviously much shorter than the time between observations demanded by the requirement that all trace of the previous configuration shall have been wiped out. Furthermore, the act of observation, by which the concept of identity acquires meaning, alters in an uncontrollable and unpredictable manner the motion of the molecules, whereas the statistical treatment requires that the molecules be undisturbed between successive observations. It seems, therefore, that the physical properties of actual molecules as suggested by quantum theory are different from those of the molecules of the model, and this would seem to demand at least designing new methods of calculating the chances of rare occurrences.

Apart from these objections, which may be met by the discovery of new theoretical methods of attack, it seems to me that the most serious difficulty with this question of rare states is met in the process of transferring to any actual physical system conclusions based on a study of the corresponding model. Suppose, for example, that we are discussing the problem of the tossing of some particular coin. If the coin is a fair coin, that is, if the chances of heads and tails are even, then our statistical model consists merely of a sequence of one or the other of two events, each of which is as likely to occur at any time as the other, absolutely independently of what may have happened elsewhere in the sequence. The theoretical discussion of this model is very easy, and we are convinced that conclusions drawn from a discussion of the model will apply to the tossing of the coin, always provided that the coin is a fair coin. As a particular problem we may consider the chance of throwing heads ten consecutive times. The chance of this is $(1/2)^{10}$, or 1/1024, which means that in every 1,000 consecutive throws the chances will be roughly even that there will be somewhere a sequence of 10 heads.[2] But 1,000 throws are a good many, and it may be that we have never made so many throws, and are content merely to make the prediction that if some one else should make so many throws it would be found to be as we say. But suppose that some one questions the fairness of the coin, and says that he has reason to think that there is a bias of 10 per cent. in favor of throwing tails, so that the chance of a head at a single throw is only 0.45 instead of 0.50. We find now on making the calculation that we shall have to make roughly 10,000 throws in order to have an even chance of getting a sequence of 10 heads; and, in general, that slight imperfections in the fairness of the coin make very large differences in the chance of rare occurrences. In view of this, we feel that it behooves us to make some objective test of the fairness of the coin before we venture to publish our prediction that we are likely to get a sequence of 10 heads in 1,000 throws. We make the most direct test possible by appealing to the fundamental definition of fairness, which is that in a large number of throws the ratio of the number of heads to tails tends to equality. But how many throws are necessary to establish such an equality with satisfactory assurance! There is another theorem here, namely that in n throws the chances are even that we shall have an excess either of heads over tails or of tails over heads of $0.6745\, n^{1/2}$. Neglecting the numerical factor for our rough purposes, this means that if we make a hundred throws the chances are nearly even that the number of heads is somewhere between 45 and 55. To establish the fairness of the coin we would have to make a considerable number of 100 throws at a time and observe whether or not the number of heads clusters between 45 and 55. If, on the other hand, there is a 10 per cent. bias in favor of tails, the number of heads will cluster between 40 and 50. The precise number of sequences of 100 throws at a time necessary to convince us that there is no 10 per cent. bias in favor of tails obeys no definite criterion, but it is certainly of the order of ten or more, which makes 1,000 or more throws altogether. But this was the number of throws necessary to obtain one of the rare sequences of 10 heads.

The conclusion from all this is plain; in order to establish with sufficient probability that the actual physical system has those properties which are assumed in estimating the frequency of rare occurrences it is necessary to make a number of observations so great that the probability is good that the rare occurrence has already been observed. In other words, purely logical statistical considerations never can justify us in predicting events so rare that they have never yet been observed. A pail of water has never been observed to freeze on the fire; statistical considerations give us no warrant whatever for expecting that it ever will. Such predictions can be made only on the basis of considerations other than statistical. Thus in the case of the coin, an exact measurement of its dimensions and of the degree of homogeneity of its metal might convince us that the chances of heads and tails were even, because of our *knowledge of the laws of mechanics.* But when we come to the molecules of a gas or the elements of other physical systems to which the statistical method of treatment is usually applied, we see that there is no method of independently handling the elements, so that the statistical method of testing the validity of our assumptions is the only possible one. This is a most natural situation, because if we were capable of dealing with the elements of the physical system as individuals we could apply more powerful methods than the statistical. Incidentally we may remark how very insensitive the statistical method is in studying elemental properties; this is shown by the example of the coin above, where we had to make something of the order of 1,000 throws to establish an asymmetry of 10 per cent. In many cases, however, the statistical method is doubtless the ultimate and the only method.

Another of the applications of statistical ideas in which there has always been much interest, and especially lately, is to the problem of the ultimate fate of the universe. It is a very common opinion that the second law, in its original classical form, demands the ultimate heat death of the universe, because of the inexorable increase of entropy to a final maximum, when all temperature differences shall have been wiped out. The chief mechanism in the ultimate equalization of temperature is obviously the radiation that is continually emitted by the stars. The human mind has, however, shown itself curiously unwilling to accept the prospect of a heat death, and there have been a number of attempts to avoid such an unwelcome conclusion. At least two of these, somewhat similar to each other, are based on the statistical interpretation of the second law. The first of these utilizes the theorem that in a closed mechanical system any configuration, once experienced, is bound to recur after the lapse of sufficient time. According to this view, the universe endlessly goes through cycles of repetition, the so-called Poincaré-Zermelo cycle, of prodigious but calculable duration. The obvious objection to this picture is that in order to realize a Poincaré-Zermelo cycle the laws of classical mechanics would have to be satisfied with an exactness quite fantastic, hopelessly beyond the possibility of direct or indirect verification. The second attempt to make satistics avoid the heat death rests on the theorem that a statistical assembly is never in complete equilibrium, but is always subject to fluctuations, and these fluctuations may attain any intensity if we only wait long enough. The present state of the universe is then to be regarded only as a fluctuation, with the possibility that similar fluctuations may recur in the future. The difficulty with this point of view is the excessive rareness of the sort of fluctuation corresponding to the present state of the universe compared with the approximate dead level of the heat death. The previous considerations apply; this is one of those configurations so rare that one has no right to predict its occurrence unless it has been previously observed. One might predict from purely statistical considerations the occurrence of such a fluctuation in the future if one were sure that one were observing such a fluctuation now. But where is the evidence for this? According to the astronomers the fluctuation has been taking the last 10^{16}, or perhaps now 10^{10}, years or so to smooth itself out to its still considerable roughness, and there is certainly no evidence that before 10^{16} years ago the entropy was decreasing instead of increasing.

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[2] I am much indebted to Mr. H. M. James for a rigorous solution of the interesting problem involved here. He finds that between 1,422 and 1,423 throws are necessary for a 0.5 chance of ten or more consecutive heads.

There are other objections to an application of the second law to the entire universe. The original formulation of the second law was, of course, restricted to isolated systems. By what logical right can the argument be extended to the entire universe? A natural reply is that relativity theory seems to demand that the universe is finite, so that the whole universe becomes the sort of isolated system demanded by the classical formulation. But I believe that examination will nevertheless show a very important difference between the smaller and the all-embracing closed system. Statistical mechanics, if it is to avoid the difficulties already discussed when applied to any individual physical situation, must make the assumption of molecular chaos. But what in the physical situation gives rise to molecular chaos? If we imagine a gas, for example, in a perfectly reflecting enclosure, and suppose that the molecules are perfectly elastic spheres, then, according to the classical picture, every collision takes place under perfectly definite conditions, so that a mathematician of sufficient power could compute backward from the present configuration to the configuration at any past time, as, for example, when a partition might have been removed from the middle of the compartment. This sort of condition certainly can not be described as molecular chaos. But the walls are molecular in structure, so that the reflection of the individual gas molecules follows no definite rule. If we regard the molecules in the wall as part of the external universe, and if there is no coordination between the motion of the molecules of the wall and what is taking place in the gas because of the enormous magnitude of the external universe compared with the gas inside, then a physical reason justifying the assumption of molecular chaos is at once apparent. When the entire universe is considered there can be no such justification as this for assuming molecular chaos, but the whole course of events must, from the classical point of view, run a rigorously deterministic course, to which statistical considerations do not apply. It may be objected to this argument that a gas in contact with its walls in the way described above is not an isolated system. It is, of course, not completely isolated, but it is nevertheless as far as the thermodynamic requirements go, which are concerned only with transfers of energy and of heat from the outside. Complete isolation would seem to be incompatible with molecular chaos.

It was intimated at the beginning of this discussion that the heat death is supposed to be a consequence of the second law, and that the continuous enormous radiation into empty space of the stars is the most striking manifestation of this tendency. This point of view sees in the emission of every photon by a star part of the inexorable increase of entropy. I believe, however, that this is fallacious, that the relations are different, and that the heat death with which we are confronted as a consequence of continued radiation is an affair of the first law, not of the second, and will take place when all the energy of the universe has been radiated away, not merely when the energy is uniformly distributed. Elementary considerations justify this contention. Consider a body radiating into empty space. It is continually dropping in temperature and losing in energy. The emission of radiation therefore decreases the entropy of the radiating body. Consider next a body in thermal equilibrium with its surroundings; since it is in equilibrium its entropy is constant, and furthermore it absorbs as much radiation as it emits. Absorption of radiation, therefore, increases the entropy of the absorbing body. This is sufficient to give a straightforward account of entropy changes in radiation problems. Consider two bodies confronting each other in a cavity at constant temperature. A photon leaves one of the bodies, decreasing the entropy of that body. During the passage of the photon across the space separating the two bodies the entropy is to be thought of as associated with the photon and residing somewhere in the intermediate space. When the second body absorbs the radiation, the photon with its entropy disappears from empty space and increases the entropy of the absorbing body. At all stages of the process the entropy of the entire system is unchanged. But now suppose that one body radiates to another at lower temperature. This process is irreversible and is accompanied by an increase of entropy. The first two steps of the process, emission of the photon and passage across the intermediate space, are the same as before, and are therefore accompanied by no net change of entropy. It is only the last stage of the process, absorption by the body at lower temperature, that can give the uncompensated increase of entropy. The mechanism of this increase is to be found in a diffusion of the energy of the photon into the greater number of degrees of freedom corresponding to the lower temperature. Actually, this argument is over-simplified, and must be modified by a consideration of the distribution of the photons through the spectrum, but the details of this point of view need not concern us further. The immediate point for us is that emission of radiation into empty space is not an entropy changing process; the increase of entropy can occur, if it occurs at all, only during the act of absorption.

But what physical evidence have we of the absorption of the light radiated by the stars? To save the situation we must postulate absorption under completely unknown conditions. But is the assumption of such unknown conditions in regions so terribly far beyond access to us in order to save the second law any easier as an intellectual feat than the assumption of other unknown conditions which would defeat the second law? Are we not completely in the dark here, and had we not better admit it?

Finally, I briefly summarize what I believe to be the principal results of this analysis and indicate the possible lines of future progress. The most important result will be, I hope, a keen realization that in using statistics we are only using a paper and pencil model, which has logical difficulties within itself and difficulties of application to concrete physical situations which are very much greater than the corresponding difficulties with more ordinary sorts of model. Some of these difficulties I believe can never be surmounted, so that the statistical model can never be satisfactorily used by extrapolation either into remote epochs of time, to predict rare events, or into remote reaches of space, to give us an idea of the course of universal evolution. Our model has not given us a satisfactory answer to our initial question as to the possibility of commercially profitable violations of the second law. The answer to this question will probably be found when the wave mechanics point of view has been completely worked out. Some of the other logical difficulties of the classical statistics, I believe, will also be surmounted by the adoption of the wave mechanics point of view, which assumes probability to be a primitive property of the elements of the model, rather than an emergent property resulting from the cooperation of great numbers. Before, however, the wave mechanics thesis of the primitive character of the notion of probability can be accepted, much more experimental work is necessary. If the thesis is supported, as seems probable from the evidence now at hand, this will constitute to a certain extent a defeat of the purpose of the classical statistics, which was to *explain* why many physical assemblages of large numbers of elements obey the rules of probability. But even granted that the primitive character of the notions of probability acquires an experimental verification, it seems to me that some of the logical difficulties will persist, justifying a doubt as to the possibility of ever setting up a logically completely satisfying correspondence between our models and our experience.

OBITUARY

CHARLES SHELDON HASTINGS

WITH the passing of Professor Hastings, America has lost its foremost expert in optics, and one to whom astronomy owes a profound debt.

Charles Sheldon Hastings was born at Clinton, New York, on November 27, 1848. He was prepared for college in the Hartford High School, and graduated from the Sheffield Scientific School in 1870. He immediately became absorbed in certain astrophysical problems, and during the succeeding years published papers: On the comparison of the spectra of the limb and the center of the sun; On the comet Cruls; On the atmosphere of Venus in transit, and On the solar eclipse of July 29, 1878.

The years from 1874 to 1877 were spent in study abroad, during which time he was a student of both Helmholtz and Kirchhoff. On his return to this country, he was appointed associate professor of physics at the Johns Hopkins University, and began the intimate study of lenses, which occupied him all the rest of his life.

The ordinary formulas for the calculation of a lens system are extremely complicated, and the attempt to make them accurate enough to serve for the designing of optical apparatus renders them almost unmanageable. Hastings conceived the idea that if he replaced the familiar ideas of indices of refraction, rays, and radii of curvature by the more natural notions of light velocities, wave and lens surfaces, which should be characterized by their curvatures, rather than by their radii, greater simplicity could be attained. He accordingly developed a method which in his hands gave very satisfactory results; by its use he was able to determine not only the spherical aberration and astigmatism of a lens, but the variation of its focal plane and its magnification, with variation of the wave-length of light.

So successful was he in these calculations, which required only the use of four-place logarithmic tables, that, as he said, he was able to do, rather simply, what elsewhere required a whole bureau of computers. The data for his computations were chiefly the indices of refraction of different kinds of glass. In order to carry out their measurement to the required degree of accuracy, he designed and constructed a spectrometer, of which the principal feature was a glass plate about 8 inches in diameter, which was divided at the limb into degrees, by diamond scratches. The settings were read by two micrometer microscopes of fairly high power, which were placed at the ends of a diameter.

The notable thing about the instrument was the great labor which he expended in determining the absolute position of each diameter. This instrument was his constant associate for over forty years, and enabled him to determine indices of refraction, accurately, to six decimal figures.

In the eighties, the variety of glasses then known did not permit the production of a truly achromatic combination. On account of the irrationality of dispersion there was always left an obnoxious secondary spectrum. With the passage of years, however, new kinds of glass were introduced, and Hastings by the study of the numerous specimens of glass was enabled by his calculations to combine them so as to practically rid objectives of secondary color. He was the first in this country to calculate their curvatures under the guidance of theory alone. But even then success was not to be hoped for by confining the effort to the mathematical aspect of the question. As the problem is a purely physical one, experiment could alone be used as an infallible guide. Mathematical consideration could only lead to the conclusion that certain constants which appear in the equations should have the same ratio as the dispersive ratio of the two varieties of glass which enter the construction. Unfortunately, the dispersive ratio is really indeterminate, in all practicable cases, and hence the necessity of testing the validity of any choice of a theoretical value for this ratio.

Any theory would adapt itself to a sufficiently small objective, and hence a rigid test could only be had by applying the theory to a large one. To have such a glass made greatly exceeded the means at his disposal, nor could he find a skilled optician who was able to shape the lenses to his curves. To meet this difficulty, he undertook to educate himself to perform this extremely accurate work. For this purpose he acquired a certain amount of general knowledge of the methods used by lens makers, by visiting the shops of various lens makers, both in this country, and in England, and in Germany, and finally, by placing himself for a time under the instruction of a skilled optician in Paris, he acquired the indispensable practical knowledge and dexterity which was essential for his purpose.

He now constructed a four-inch objective from two carefully studied glasses, on the hypothesis that the spherical aberration for rays of mean wave-length should vanish, and that the sum of the squares of the chromatic aberration for the other wave-lengths, weighted according to their respective luminosities, should be a minimum. The objective was carefully constructed, after improving the form of the spherometer so as to greatly increase its delicacy.

The experiment proved a failure. A careful remeasurement of the surfaces and a repetition of the computations demonstrated that the theory was certainly at fault.

He next selected a different method for determining the most appropriate value for the dispersive ratio, imposing a condition as to the amount of light energy sent very near the geometrical focal image of a distant point. A four-inch glass was ground in accordance with curves, computed on this new basis, and the telescope proved to be an admirable one, with corrections, both for spherical aberration and color, sensibly perfect. Successively, larger and larger objectives were later constructed, which proved of the highest excellence.

From 1884 till 1915, when he retired, Hastings was professor of physics in the Sheffield Scientific School, and for many years acted as consulting expert for the Brashear Company.

Obviously, an objective corrected for visual use is of no value for photographic purposes. Hastings, however, made correcting lenses for transforming visual into photographic refractors and brought the spectroscope to a very high degree of perfection.

The largest telescope of his design is the 30-inch photographic objective of the Allegheny Observatory, and is a very perfect glass. Other constructions from his calculations are the 26-inch photographic objective for the Yale Observatory in South Africa; the 24-inch visual refractor at the Chabot Observatory at Oakland, California; the 18-inch visual objective at the University of Pennsylvania; a twin doublet of 16-inch aperture at Heidelberg, Germany; a 72-inch reflector at Victoria, B. C., and the 15-inch photographic Loomis coelostat at the Yale Observatory, New Haven. This telescope has a focal length of fifty feet, and is the third longest telescope in the world.

Another of his achievements was the construction of an anastigmatic magnifier which is very widely used.

Two or three years before his death, he perfected an improvement in the microscope, which he regarded as highly successful and important, but his increasing disabilities prevented his communicating the detail of his design, and it is to be feared that his results are lost to the world.

Hastings was always interested in all optical phenomena. In 1920, he published a general theory of halos, on the hypothesis of two simple kinds of ice crystals, by which he was able to explain all the general features of complex halos.

His published works number some forty odd pamphlets, and the following three books: "General Physics," written in collaboration with Frederick E. Beach, in 1898; "Light," which was published in 1901, as one of the Yale Bicentennial Publications, and "New Methods in Geometrical Optics," published in 1927.

He was a man of wide culture, and deeply interested in literature, art and architecture. In 1909, after extended study of the notable asymmetries of the Cathedral of Pisa, and other European churches, he published a paper, "On the Architectural Refinements in Medieval Churches."

Hastings was always uniformly cordial but possessed a personal dignity through which one rarely passed to familiarity. He will always be remembered as a courtly gentleman of the old school.

Frederick E. Beach

RECENT DEATHS

Dr. Louis Agricola Bauer, director emeritus of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, died on April 12 as the result of a fall from a window of his apartment. He was sixty-seven years of age.

J. Hammond Smith, of the College of Engineering of the University of Pittsburgh, died suddenly on April 13. He was sixty-five years old.

Dr. Donald R. Dickey, research associate in vertebrate zoology at the California Institute of Technology, died on April 15, at the age of fifty-five years.

Professor Charles G. Simpson, professor of mathematics in the School of Engineering, Milwaukee, died on February 5, at the age of sixty years.

H. Chapman Jones, formerly for many years senior demonstrator in chemistry in the Royal College of Science, London, died on March 7, aged seventy-seven years.

Sir Horace Plunkett, first vice-president of the Department of Agriculture and Technical Instruction for Ireland, known for his contributions to Irish agriculture, died on March 26, aged seventy-seven years.

The death is announced, at the age of seventy-eight years, of Sir Patrick Geddes, in Montpellier, France, where he was director of the Scots College. He was distinguished as a biologist and had held teaching posts in London, Aberdeen, St. Andrew's and Edinburgh universities.

SCIENTIFIC EVENTS

A NEW TUBERCULOSIS BUILDING AT THE PASTEUR INSTITUTE

To the Institut Pasteur de Paris has been added, according to the Paris Correspondent of the *Journal* of the American Medical Association, a large five-story building, erected in the gardens and reserved for studies on tuberculosis and for the preparation of the B C G vaccine, the demands for which have constantly increased, coming from all parts of the world. Only 890 doses were sent out in 1924 and in 1931, 101,646 doses. Since the creation of the B C G vaccine, 414,198 vaccinations have been performed. The new building cost $400,000, and was recently formally opened by the minister of public health, with the attendance of representatives of the medical press and numerous scientists. Mr. Calmette himself conducted visitors about the building. He showed the first strains of the B C G vaccine, which date from February 8, 1908. The transplantations of the cultures, from week to week, on ox bile were kept up until 1919, in order that the bacillus should become absolutely harmless, and it was not until five years later, experiments having been constantly made, in the meantime, on animals, and the demonstration having been made that the bacillus could not regain its virulence, that Calmette and Guérin decided to apply their vaccine to man. The recent Lübeck tragedy has clearly proved that only the introduction of virulent bacilli into the cultures can deprive them of their harmlessness. In the preparation of the vaccine, the most rigorous asepsis is followed. Every week transplantations of the cultures, which are preserved in baths at a temperature of 38° C., are made. The collected emulsion is distributed in tubes of 1 cc capacity, and each containing 5 mg of tubercle bacilli. Each tube contains thirty doses, which, at the rate of three doses by mouth daily, suffice for ten days' treatment. One entire story of the building is reserved for these operations, this story being completely separated from the other parts of the building, in which are the laboratories of Messieurs Nègre, Valtis and Boquet, the laboratories for the preparation of tuberculin, the anatomic laboratories, the laboratories for experimental physiology, chemistry and others. A *bacillothèque* (filing cabinet) contains all the strains of bacilli—human, bovine, avian and the like. The B C G strain is kept in a special bath, of which only Mr. Guérin has the key. In other cabinets are filed the records pertaining to each request for vaccine, together with the responses announcing the results secured, so that absolutely correct statistics are readily available. In the basement are the necropsy rooms and the cages for 6,000 animals (chiefly guinea-pigs) used for experiments. The Pasteur Institute uses 8,000 guinea-pigs annually.

THE X-RAY UNIT OF THE HOSPITAL OF THE UNIVERSITY OF MICHIGAN

After four months of remodeling and installing new equipment, the University of Michigan Hospital, which now handles a volume of x-ray work second only to the Mayo Clinic in Minnesota, opened recently its new x-ray department, which is said to be unexcelled by any similar installation in the country.

The new unit is featured by a novel plan of rooms and apparatus which stresses convenience and privacy for patients and the quick processing of the x-ray films. From waiting rooms the patients are directed to private dressing rooms from which they pass as called by private corridors to the proper department. A complete "traffic system" of lights, which indicate what rooms are in use to all offices of physicians and the directing staff, makes possible quick routing of patients, so that routine x-ray examinations may be made at the rate of twenty an hour.

Rapid development of films to aid physicians to make an early diagnosis is made possible by a modern dark room, provided with dry air from which all moisture has been chilled out by special refrigerating machinery. Once in operation for the day, the room need never be lighted or work stopped, the completed films being passed out through a double-doored, light-tight well for final rinsing and drying From the drying rack they may be taken directly to the physicians' offices, each of which has its own viewing apparatus, so that a report may be given in a fraction of the usual time needed.

Among other details of the equipment are lead lined rooms which confine the rays of high voltage treatment apparatus, with lead glass windows through which the doctor or technician may observe the patient, a room in which x-ray films of the chest of bed-ridden patients may be taken through the bed by apparatus beneath the floor, special equipment for locating foreign bodies in the eye, and automatic apparatus, which, as soon as one patient's films are made, resets itself for the second stereoscopic exposing. Memorializing Dr. Preston M. Hickey, for many years head of the department, is a staff library which will contain publications on roentgenology, given by Dr. Hickey's friends, former associates and assistants, and a complete set of special x-ray studies of normal and diseased parts for reference. Classrooms, and research laboratories for medical students are also provided within the department. The memorial bas-relief of Dr. Hickey, presented this last year by the American Roentgen Ray Society, has been hung in the special conference room set aside for the members of the hospital staff who wish to review the examination of their patients with members of the roentgenology staff.

EXHIBIT OF THE PHILADELPHIA MINERALOGICAL SOCIETY

The annual exhibit of the Philadelphia Mineralogical Society opened on April 17 in the Free Natural History Museum of the Academy of Natural Sciences. All the specimens are shown by members of a group of amateur mineralogists whose hobby is collecting minerals in near-by quarries, mines, valleys and hills, or wherever rocks are exposed.

The exhibit this year, which will be open free to the public until April 25, is confined entirely to minerals collected within a day's journey of Philadelphia in Pennsylvania and New Jersey—most of them rare and unusual crystals incidental to the mining and quarrying industry. For the granites, gneisses and other metamorphic rocks of the neighborhood frequently contain veins of interesting minerals. Over 100 minerals, or nearly ten per cent. of all those known to science, have been found within the city limits of Philadelphia.

Two groups of quartz crystals from Bridgeport, Pennsylvania, are exhibited by Mr. A. Fleming, Jr., and calcite crystals from Howellville, by Mr. E. H. Ceinkowski. Showy blue cyanite and garnet from Prospect Park, Delaware County, is exhibited by Mr. C. H. Jackson. A rather extensive series of local minerals is shown by Mr. Harry W. Trudell, director of the Frankford Institute for Medical Research, whose collection is perhaps the finest private one in Philadelphia.

The rock crystal and crystal ball are exhibited by Mr. Morrell G. Biernbaum. Petrified wood from Lindenwold, N. J., and Newton, in Bucks County, have been loaned for the exhibit by Mr. W. H. Flack. Brilliant pyrite, magnetite, sphalerite and galena are mute evidence of the iron, lead and zinc mining near Phoenixville many years ago. A series of especial interest to beginners and boy scouts is that of "fifty minerals which can be found at 10 localities near Philadelphia." Other exhibitors are Messrs. J. S. Frankenfield, George Petersen, E. A. Groth, William Knabe and Horace J. Hallowell.

THE AMERICAN MEDICAL ASSOCIATION

THE annual meeting of the American Medical Association will be held at New Orleans, opening on Tuesday evening, May 10, when Dr. E. H. Cary, professor of ophthalmology and otolaryngology at the medical school of Baylor University and dean emeritus of the school, will be installed as president. He succeeds Dr. E. Starr Judd, of the Mayo Clinic, Rochester, Minnesota. The president's reception will be on Thursday evening, May 12.

The meetings of the scientific sections will begin on Wednesday morning, May 11, and will continue through Friday, May 13. These are as follows: Practice of Medicine and Diseases of Children; Surgery, General and Abdominal; and Obstetrics, Gynecology and Abdominal Surgery; Ophthalmology; and Laryngology, Otology and Rhinology; Pharmacology and Therapeutics; and Pathology and Physiology; Nervous and Mental Diseases; and Orthopedic Surgery; Preventive and Industrial Medicine and Public Health; and Gastro-Enterology and Proctology; Dermatology and Syphilology; and Urology; Radiology.

The House of Delegates will convene for its first meeting at 10 A. M. on Monday, May 9. All meetings of the House of Delegates will be held at the Roosevelt Hotel.

The clinical lecture program will be given on Monday afternoon, May 9, and on Tuesday morning and afternoon, May 10, at the Municipal Auditorium. Topics to be discussed are of important practical interest to the rank and file of the profession. This program will include the following lectures:

Drug Addiction—A World-Wide Problem, P. Wolff, Berlin, Germany.

Drug Addiction in the United States, Walter L. Treadway, Washington, D. C.

Cancer of the Gastro-Intestinal Tract, J. Shelton Horsley, Richmond.

The Changing Diet of the American People, Lafayette B. Mendel, New Haven.

The Diagnosis of Early Pulmonary Tuberculosis, Lawrason Brown, Saranac Lake.

Disturbances of Peripheral Circulation, Arthur W. Allen, Boston.

Appendicitis, H. A. Royster, Raleigh, N. C.

Early Diagnosis of Poliomyelitis, Lewis J. Pollock, Chicago.

Use of Convalescent Serum in Poliomyelitis, William H. Park, New York.

Orthopedic Treatment of Poliomyelitis, Willis C. Campbell, Memphis, Tennessee.

Motion Picture on Cancer, Francis Carter Wood, New York.

In addition to Dr. P. Wolff, secretary of the Narcotic Committee of the League of Nations, secretary of the German Council of Therapy and editor of the leading medical publication of Germany, who will participate in the clinical lecture program given above, Sir Arthur Newsholme, of Birmingham, England, known for his work in the field of public health, will be one of the participants in a joint symposium of the Section on Practice of Medicine and the Section on Preventive and Industrial Medicine and Public Health. Sir Arthur's topic will be "The Relation of Private Practice to Preventive Medicine in Europe." Professor N. Krasnogorski, of Leningrad, will contribute a paper on "Conditioned Reflexes in Psychopathology of Childhood" to the program of the Section on Diseases of Children.

FELLOWSHIP AWARDS IN THE SCIENCES AT YALE UNIVERSITY

THE Yale University Graduate School announces the award of 178 fellowships and scholarships, the recipients selected from more than one thousand applicants. Thirty-seven have been awarded research fellowships. As in former years these permit of an international exchange of scholars. From Göttingen will come Dr. Max F. Düring to work with Professor Oystein Ore on algebraic numbers, while Mr. Milton S. Plesset, of Pittsburgh, a candidate for the doctorate in physics at Yale this June, will go to Copenhagen to carry out further research under Professor Bohr. Two European zoologists, Dr. Paul A. Weiss, of Vienna, and Dr. Oscar E. Schotte, of Geneva, will continue research begun this year with Professor Ross G. Harrison in the Osborn Zoological Laboratory.

Dr. George Scheff, of Pecs, Hungary, has been offered a renewal of the Alexander Brown Coxe fellowship to continue his bacteriological research with Professor Leo Rettger, while Dr. Maximilian Steiner, of Vienna, has been awarded a Seessel fellowship to work with Professor George E. Nichols at the Osborn Botanical Laboratory on the chemical nature of changes in the osmotic pressure of plants.

Dimitri P. Krynine, a Russian engineer, known for his work in the field of soil mechanics, has been awarded a Sterling fellowship to pursue his research on the permeability of soils.

Ebbe C. Hoff, of Lindsborg, Kansas, a candidate for the Ph.D. at Oxford this year, has been awarded a

Sterling fellowship for research with Professor John F. Fulton in neuro-physiology.

For psychological research, Dr. Helen Peak, of Dallas, Texas, has been awarded a Sterling fellowship to enable her to continue work with Professor Raymond F. Dodge on the speed of reaction of the eyelid in organisms at various phylogenetic levels, while a somewhat related study of eye movements is made possible by the award of an Alexander Brown Coxe fellowship to Dr. Frank H. Couch, of Cromwell, Connecticut, to make it possible for him to carry on his work with Professor James C. Fox.

A special research fellowship in bacteriology has been awarded for the first time this year. Dr. Louis Weinstein, of Bridgeport, Connecticut, is the recipient. He will study the relationship of bacterial flora of the gastro-intestinal tract to the psychological reactions of the animal host.

A Sterling fellowship has been awarded to Charles E. Olmstead, of Roca, Nebraska, to study the effect of year to year differences in climatic conditions on wood structure of native trees. He will work with Professor Nichols at the Osborn Botanical Laboratory.

Paleontological research on the gastropods of the St. Louis, Pennsylvania outlier, has been made possible by the award of a Sterling fellowship to Dr. J. Brooks Knight, of Branford, Connecticut.

Mr. Frederick N. Rhines, of Toledo, Ohio, has been appointed Sterling fellow for research in metallurgy. He will study the rôle of oxygen in some of the common metals.

At the Sloane Physics Laboratory honorary research fellowships have been awarded to Dr. Malcolm Henderson and to Donald Cooksey, who is a candidate for the Ph.D. this June. Dr. Henderson will continue his experiments in the field of radioactivity while Mr. Cooksey works on precision measurements in high frequency spectra.

SCIENTIFIC NOTES AND NEWS

The meeting of the National Academy of Sciences on the evening of April 25 will be given to the celebration of the hundredth anniversary of the electrical discoveries of Joseph Henry. The addresses will be: "Henry as a Physicist" by Dr. W. F. Magie, professor of physics at Princeton University; "Henry as an Electrical Pioneer" by Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Company, and "Henry as an Administrator" by Dr. C. G. Abbot, secretary of the Smithsonian Institution.

The evening address of the American Philosophical Society will be given on April 23 by Dr. Paul van Dyke, professor of modern European history at Princeton University, who will speak on "The Human Washington." At the annual dinner on the evening of April 23 the speakers will be Dr. James Brown Scott, secretary of the Carnegie Endowment for International Peace; Dr. Howard McClenahan, secretary of the Franklin Institute; Dr. Thomas S. Gates, president of the University of Pennsylvania, and Dr. William B. Scott, emeritus professor of geology and paleontology, Princeton University.

The annual meeting of the trustees of Science Service will be held in Washington on Thursday, April 28. On the preceding day there will be a round table conference and a dinner to consider how Science Service may further its purpose of making science better known and appreciated by the general public and contribute its share in advancing modern civilization. Those who will take part in the conference include Dr. Karl T. Compton, Massachusetts Institute of Technology; Dr. Edwin G. Conklin, Princeton University; Dr. Simon Flexner, Rockefeller Institute for Medical Research; Dr. Frank B. Jewett, Bell Telephone Laboratories; Mr. A. H. Kirchhofer, the *Buffalo Evening News;* Dr. John C. Merriam, Carnegie Institution of Washington; Dr. A. A. Noyes, California Institute of Technology; Mr. Robert P. Scripps, Scripps-Howard Newspapers; Dr. E. B. Wilson, Harvard University School of Public Health. The speakers at the dinner will be Dr. John H. Finley, *The New York Times;* Dr. Robert A. Millikan, California Institute of Technology, and Dr. H. G. Moulton, Brookings Institution.

Dr. Arthur P. Coleman, emeritus professor of geology, University of Toronto, has been awarded the Victoria Medal of the Royal Geographical Society in recognition of his geographical work in Canada. Professor Coleman celebrated his eightieth birthday on April 4, when he was the recipient of many messages of congratulation from friends and colleagues at home and abroad. He is actively engaged in preparing a report on the glacial geology of southern Ontario for the Ontario Department of Mines.

Dr. Selman A. Waksman, of the department of soil microbiology, Rutgers University, and the New Jersey Agricultural Experiment Station, has been elected a member of the Imperial German Academy of Sciences at Halle, in recognition of his work on the microbial population of the soil.

Professor Roger L. Morrison, of the highway engineering department of the University of Michigan, has been elected an honorary member of the Institute of Highway Engineers at Cambridge, England.

IT is reported in *Nature* that in view of the conferring of the honorary degree of D.Sc. by the University of the Witwatersrand, Johannesburg, on Mr. N. E. Brown, in recognition of his work on the South African flora, Sir Arthur Hill presented Dr. Brown to his old colleagues in the Herbarium of the Royal Botanic Gardens, Kew, on March 19. In the course of a short address, Sir Arthur said: "Dr. Brown was on our staff for forty-one years, from 1873 until 1914. He was elected an associate of the Linnean Society in 1879, and in 1921 he received the Senior Captain Scott Medal for scientific research in South Africa from the South African Biological Society. I need not detail his many contributions to South African botany, as they are so well known to all botanists, but it is interesting to record that the following eminent South African botanists warmly supported the proposal that Dr. Brown should be honored by South Africa: General J. C. Smuts, Dr. I. B. Pole Evans, Professor J. W. Bews, Professor R. S. Adamson, Professor R. H. Compton and Dr. John Muir."

DR. FREDERIC H. LAHEE, chief geologist of the Sun Oil Company, Dallas, Texas, who has been for three years third vice-president of the American Association of Petroleum Geologists, was elected president at the annual meeting.

AT the ninth annual meeting of the Alabama Academy of Science, held at Howard College, Birmingham, on March 11 and 12, the following officers were elected: *President,* Dr. J. F. Duggar; *Vice-presidents,* Dr. J. L. Brakefield and Dr. H. C. Heath; *Secretary,* Dr. B. P. Kaufmann; *Treasurer,* Mr. A. G. Overton; *Editor,* Dr. E. V. Jones; *Councillor to the American Association for the Advancement of Science,* Dr. E. B. Carmichael. Birmingham-Southern College was selected for the 1933 meetings.

AT the annual business meeting of the Royal Philosophical Society of Glasgow, held on March 23, the following officers were elected: *Vice-president,* Dr. Henry L. G. Leask; *Honorary Librarian,* Dr. James Knight; *Honorary Treasurer,* Sir John Mann; *Secretary,* Mr. John A. Buyers; *Members of Council,* Mr. John P. Heslin, Miss M. A. Hannan Watson and Mr. George B. Wishart.

PROFESSOR FRANK A. WAUGH, who for the past thirty years has directed the horticultural work of the Massachusetts State College, will retire on September 1 as head of the horticultural division in order that he may devote his entire time to the department of landscape architecture, of which he will continue as head. Dr. Ralph A. Van Meter, professor of pomology and a member of the staff for fifteen years, was promoted to head of the division. Professor Waugh is now on a six-months' leave in Japan for the purpose of studying Oriental gardening methods.

MR. ROBERT L. NUGENT, until recently physical chemist at the Gladwyne Research Laboratory and instructor in biochemistry in the Graduate School of Medicine of the University of Pennsylvania, has become assistant professor of chemistry at the University of Arizona.

DR. EDWIN O. JORDAN, of the University of Chicago, has been appointed a member of the Chicago Board of Health.

THE first Joseph A. Capps Prize for medical research of the Institute of Medicine of Chicago has been awarded to Dr. Warren B. Matthews, assistant resident in surgery at the University of Chicago clinics, for his paper on "Studies on the Etiology of Gastric and Duodenal Ulcer." This prize of five hundred dollars, established through the generosity of an anonymous donor, is awarded in alternate years for the most meritorious medical research by a graduate of a medical school in Chicago completed within two years after graduation.

THE award of the J. T. Baker Chemical Company Eastern Analytical Fellowship for 1932–33 has been made to Mr. Eugene Wainer, a graduate student at Cornell University. Mr. Wainer has worked with Professor Papish in research for Element No. 87 (*Journal of American Chemical Society,* 53, 3818, 1931). He plans to make a study of x-ray spectroscopy as a means of quantitative analysis under the direction of Professor Papish.

IN a letter written at Iquitos, Peru, on March 18, M. W. Stirling, chief of the Bureau of American Ethnology, states to the Smithsonian Institution that he had just completed an 800-mile trip on a raft via the rivers Yangtse, Santiago, Maranon and Amazon. His ethnological collection of Jivaro and Aquaruna material came through in good shape. Mr. Stirling hopes to reach Washington early in May.

DR. MARGUERITE LEFEVRE, chef de travaux in the University of Louvain, who as the holder of a fellowship under the Commission for Relief in Belgium Educational Foundation, has been prosecuting studies in geomorphology at Columbia University, is devoting a month to the study of ancient marine levels in South Carolina, Georgia and Florida.

DR. CHARLES E. SPEARMAN, of the University of London, will deliver on April 23 the principal address at the annual meeting of the University of Kentucky chapter of Phi Beta Kappa. His subject is "The Abilities of Man."

THE annual lecture of the James A. Gibson Antomical Society at the University of Buffalo was given on April 8 by Dr. G. Carl Huber, professor of anatomy and dean of the Graduate School at the University of Michigan. The subject of Dr. Huber's address was "The Kidney."

DEAN GEORGE F. KAY, of the State University of Iowa, gave the address at the annual Phi Beta Kappa, Sigma Xi Convocation at Washington University, Saint Louis, on April 7. His subject was "Scientific Discovery and Human Outlook." While at the university, Dean Kay also gave a lecture before the faculty and students of the science departments on "The Glacial History of Iowa and Adjacent States."

DR. R. A. EMERSON, head of the department of plant breeding in the New York State College of Agriculture, Cornell University, gave the third series of annual lectures under the Frank Azor Spragg Memorial Fund, from April 5 to 8, at Michigan State College. This memorial is in honor of Professor F. A. Spragg, who was in charge of plant breeding work at the Michigan Agricultural Experiment Station from 1906 until his death in 1924. The subjects dealt with in the lectures were: "Cooperation in Plant Breeding"; "Heredity and Environment" (a non-technical lecture); "Breeding White Beans for Disease Resistance, Yield and Canning Qualities"; "The Present Status of Corn Genetics and Cytology," and "The Solving of a Genetics Problem—the Inheritance of Variegated Pericarp in Corn."

Two lectures will be given on May 3 and 5 under the Edward K. Dunham Lectureship for the Promotion of the Medical Sciences at the Harvard Medical School by Dr. Ludwig Pick, professor of pathology, University of Berlin, and director of the Pathological-anatomical Institute Municipal Hospital, Friedrichshain, Berlin. The lectures will be given each day at 5 o'clock. The subjects will be " A Classification of the Diseases of Lipoid Metabolism and Gaucher's Disease" and "Niemans-Pick's Disease and other Forms of so-called Xanthomatosis."

SIGMA PI SIGMA, honorary physics fraternity, installed its twenty-first chapter at the University of Richmond on March 16. The installation ceremonies were held in the physics lecture room of Richmond Hall with Dr. Marsh W. White, the executive secretary of the society, and Dr. R. C. Young, former president and member of the executive council, as installing officers. Nineteen charter members, including Dr. R. E. Loving, head of the physics department, and Dr. C. L. Albright, were initiated as charter members of the Chi chapter. After the installation dinner the first open meeting of the chapter was addressed by Dr. White, who spoke on "Energy Relations in X-ray Tubes."

THE thirteenth annual meeting of the American Geophysical Union will be held in the building of the National Academy of Sciences, Washington, on April 28 and 29. Dr. William Bowie is chairman of the union. Dr. L. H. Adams is vice-president and Dr. J. A. Fleming general secretary. The chairmen of the sections are: Geodesy, W. D. Lambert; seismology, N. H. Heck; meteorology, G. W. Littlehales; terrestrial magnetism and electricity, D. L. Hazard; oceanography, A. H. Clark; volcanology, A. L. Day, and hydrology, O. E. Meinzer.

THE second International Congress of Tropical Medicine, which was to have been held in Amsterdam next September, has been postponed until financial conditions are more favorable.

DEFINITE plans have been made for the removal of the North East Forest Experiment Station from Amherst to New Haven. Three specialists moving with the station are Dr. Perley Spaulding, forest pathologist of the bureau of plant pathology; Harvey MacAloney, entomologist of the bureau of plant entomology, and Paul Miller, of the bureau of biology.

THE Eugene Littauer Memorial Laboratory for diagnosis and research was recently presented to the Nathan Littauer Hospital in Gloversville, N. Y., by Lucius N. Littauer. The laboratory is a memorial to Mr. Littauer's brother and the hospital, built several years ago, to his father. Among guests at the dedication were Drs. James Ewing and Emanuel Libman, New York; Elliott P. Joslin, Boston; Edward Francis, Washington, D. C.; Milton C. Winternitz, New Haven, and Harrison S. Martland, Newark, N. J., all of whom made addresses. The building has two floors; on the first are the diagnostic laboratories and the second is planned for research, while the basement contains the necropsy, histologic and photographic rooms.

Nature reports that Lord Wakefield has given a sum of £25,000, spread over seven years, as a contribution to the British Imperial Institute. The institute is financed by annual grants from the Treasury, the Dominions, India and the Colonies, and was faced with the prospect of curtailment of its activities, owing to temporary reduction of some of its supporting grants. It is hoped that Lord Wakefield's gift will enable the institute to tide over the period of difficulty.

Museum News reports that a museum is included in the plans for the building of the Institute of Polar Research to be erected at Cambridge, England. The building is to be a memorial to Captain Robert Falcon Scott, whose navigation book for his last expedition will be one of the exhibits. Specimens of sledging gear, clothing, cooker's instruments and Polar equipment of all kinds will be collected. Material from

Sir John Franklin's expedition will be included. A grant of $200,000 has been contributed toward the building by the Pilgrim Trust Fund, founded by Mr. Edward S. Harkness.

The Munich correspondent of *The New York Times* reports that another German expedition is being made to the Himalaya this summer. The party, which will be nine or ten in number, consists for the most part of first-class Bavarian mountaineers and members of the Munich Alpenverein, but two or three members of the American Mountaineering Club are on their way from the United States to take part in the expedition. The expedition will attempt the ascent of Nanga Parbat, 26,629 feet, in the Kashmir Himalaya. If successful, the climbers will have reached a summit higher than any yet attained by man, though not the highest point reached—a record held by Mallory and Irvine on Mount Everest. Only one previous attempt has been made to scale Nanga Parbat; this was in 1895, when the British mountaineer, A. F. Mummery, lost his life in the venture. The leader of the German expedition is Herr Wilhelm Merkl, a Munich engineer, who, in 1929, took part in an expedition across the Caucasus which included an ascent (the third on record) of the extremely difficult Uschba Mountain. The expedition will leave Munich on April 26 and will depart from Srinagar, the capital of Kashmir, *en route* for the mountain, early in June.

DISCUSSION

THE ANALYSIS OF ELECTROMYOGRAMS

The method described by Travis and Hunter[1] in a recent issue of SCIENCE for the study of the human electromyogram calls for comment, since it seems to be almost expressly designed to obscure well-established physiological facts concerning the activity of the central nervous system. Their method consists essentially of determining what percentage of the "output voltage" will pass various electrical filters designed to eliminate alternating current components above a given frequency. The authors offer the method as a means of "reading" the irregular electrical disturbances generated during muscular contraction. The implication is inescapable that they anticipate analyzing the "action current wave" into its components and interpreting variations which may be found under various conditions. They neglect, however, to evaluate their method in the light of the known facts of muscular physiology. The action currents of muscles in voluntary contraction present an irregular and confused picture due to the combined asynchronous activity of many individual units. Each active unit generates a series of electrical pulses or action currents at a rather slow and more or less regular rhythm. The way to clear interpretation does not lie in an analysis of the resulting total disturbance in terms of frequencies as revealed by electrical filters, since this method implicitly assumes that the whole is composed of a variety of alternating current components of various frequencies. The total action current can be described in this way, but the result has little connection with the underlying phenomena, and therefore can only be misleading.

Adrian and Bronk[2] have shown that by means of a hypodermic needle, which contains within it a fine insulated wire, effective contact can be made with a relatively small number of active muscular units. We have repeated their observations and confirmed the fact that the rhythms of individual units appear clearly in the record of contractions of moderate intensity. This method offers a direct analysis of the situation, and demonstrates immediately that the number of impulses per second in each motor unit in voluntary contractions is of the order of ten to fifty or a hundred. The method of Travis and Hunter completely misses this fundamental fact, only 10 per cent. of the total action current being ascribed by them to frequencies below one hundred.

The peak of frequencies represented, according to Travis and Hunter, lies at about 400 per second. This result almost certainly depends upon the time-relations of the individual action currents in the muscle fibers. These rise from zero to their maximum voltage in approximately a thousandth of a second and fall again somewhat more slowly. Waves of these time-relations, whether recurring regularly or irregularly, when confronted by a series of graded electrical filters will not be greatly reduced by those which pass frequencies up to 1,000 per second but will be considerably reduced by those whose limit is 400 and very much so by 200. In other words, these waves will have a large component between 300 and 500 when analyzed by filters, whether the waves occur singly, or at regular intervals or at random. Travis and Hunter's frequency curve therefore depends primarily upon the shape of the individual impulses and not upon the fequency of their occurrence. It is the latter which varies with different degrees of activity of the neuro-muscular system while the former is relatively constant and depends upon the local condition of the muscle itself. If it is desired to study frequency it is now quite easy to obtain a record of a series of individual impulses which one may "read" quite easily, and, if desired, a Fourier analysis may be applied to the oscillograms of the individual impulses.

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[1] L. E. Travis and T. A. Hunter, SCIENCE, February 19, 1932.

[2] E. D. Adrian and D. W. Bronk, *J. Physiol.*, Vol. lxvii, No. 2, p. 119, 1929.

Why endeavor to infer the properties of an individual egg from an omelette, even by means of elaborate chemical analysis, when the individual eggs can be purchased separately?

H. DAVIS
A. FORBES
L. GARCEAU

THE PINE FORESTS OF COSTA RICA

IT was not through oversight that in his "Plantas Usuales de Costa Rica" Professor H. Pittier failed to mention the occurrence in that country of pine trees. No one knows the vegetation of Costa Rica so well as the writer of that now almost classic report, and if trees so important economically as pines did occur in Costa Rica, he could not be pardoned for neglecting them.

But, in a recent volume devoted to the "Tropical Forests of the Caribbean" (Gill, 1931), the reader is informed that "In British Honduras pine extends practically to the coast, but in Costa Rica it is confined to the uplands, and in Panama fades out entirely" (whatever the last phrase may mean). Opposite the page (p. 151) on which this statement appears, there is a map illustrating the distribution of pine forest in Central America. There is a modest strip of black extending the length of what apparently is intended as the main cordillera of Costa Rica (which does not exist), with a discreetly reduced, isolated patch of black farther south, near the Panama border.

Further, on page 317, under Table No. 3, it is stated that the forest area of Costa Rica consists of eight millions of acres, of which one million acres are reported optimistically as "conifers." Under "remarks" there appears the distressing information, "Pine type badly injured by fire."

The present writer is not prepared to criticize the forest data reported for other countries, although to one who has traveled by railroad from Puerto Barrios, Guatemala, to Guatemala City it is evident that the distribution of pine forest as indicated for that country is erroneous. Likewise, a botanist who has studied the flora of the Pacific coast of Central America will be unable to comprehend why Pacific Nicaragua should be mapped as "deciduous" forest, and all the rest of the Central American coast as "rain" forest. The facts are that exactly the same species of trees characterize the Pacific flora all the way from Guatemala at least as far as the Nicoya Peninsula in Costa Rica, and to Panama, for that matter. Floristic areas, unfortunately, do not usually coincide with political boundaries; it would make work easier for the systematic botanist if they did.

The subject of the southern limit of pine trees (and of all conifers) in North America is a matter of substantial scientific and economic interest, else it would not deserve mention here. In a book which purports to be scientific, the information published should be as accurate as possible, or else omitted. The distribution of pines in tropical America has been discussed by competent writers, and the facts could have been obtained without any great amount of research. Thomas Belt, in "A Naturalist in Nicaragua," reports that when traveling northward from Chontales, he observed the first pines in the vicinity of Matagalpa, and that is probably their southernmost extension in North America. (They do not occur, of course, in South America.)

The quotation cited in the second paragraph of this article should be corrected to read: "In Costa Rica pines are confined to dooryards," and in the table mentioned the area should be reduced from one million acres to one acre. A plot of that size, perhaps with a little crowding, would contain almost all the pine trees of Costa Rica. They do exist, it is true, for in two winters passed in the "uplands" I have seen some of them, but they were always about houses, and evidently planted. Systematic questioning of country people and of educated persons thoroughly familiar with the country failed to elicit a single report of the existence in Costa Rica of a native pine tree. In a recent letter to the present writer, Mr. F. Charles Clark, a lumber exporter of San José, Costa Rica, writes: "I have traveled practically all over the forests of this country, I might say, looking for native pine (genus *Pinus*), without success. I can not imagine anyone making a statement that there are millions of acres of pine trees in this country, and I, for one, should like to come across the first native tree." Friends of forest conservation may be comforted by the fact that under the circumstances it is scarcely possible that the Costa Rican pines have been "badly injured by fire."

PAUL C. STANDLEY

FIELD MUSEUM OF
NATURAL HISTORY

THE SOARING OF TURKEY BUZZARDS

THOUGH the means by which certain birds accomplish their soaring flight with wings held stationary is by no means the mystery it was before man learned to make use of upward air currents in flight with motorless gliders, the following observation seems of interest. The observation may not be unusual, yet neither myself nor any of the half dozen others who witnessed it had previously noticed it.

On a calm, very hot afternoon in August, 1931, in the level region of east central Illinois, a straggling flock of turkey buzzards were observed approaching from the north at a height of approximately five hundred feet. They were soaring along on a straight course with wings stationary. Not far from the observers they came underneath one of the scattered cumulus clouds present at the time and at once discontinued their flight toward the south and began to soar in circles, keeping directly beneath the cloud. During this circling, with wings still held stationary, they rapidly gained elevation, so that the course of each bird became a spiral. This upward, spiral, soaring flight continued for some minutes until the birds had become hardly visible, when they again resumed their southward course at a much greater elevation than before they had come underneath the cloud. A few minutes later a second flock of about a dozen came along from the north and under the same cloud gained elevation, as had the first one.

This is evidently a case where the birds made use of the upward air current beneath the cumulus cloud to gain elevation without resorting to wing strokes and the writer has been wondering if this is matter of common observation.

G. S. DODDS

WEST VIRGINIA UNIVERSITY

ON THE EARLY HISTORY OF PLATINUM

IT is quoted generally throughout text-books and related literature that the first mention of platinum occurs about 1750. James Lewis Howe, in his "Bibliography of the Metals of the Platinum Group," including the years 1748 to 1917, states that the first reference to platinum is in the volume of don Antonio de Ulloa, "Relacion historica del viaje a la America Meridional," published in Madrid, 1748. The next reference is of 1751 when platinum was described in the literature by Watson and Brownrigg, and in the same year the properties of the ore were described by T. Scheffer.

As we know from historical record, don Antonio de Ulloa was not the first to write of the New Americas nor even among the very first to go there from the old country, so that it would not be altogether amiss to suppose that earlier commentators on the new lands, especially on Nuevo Granada as the Republic of Colombia was then known, might make mention of this curious "unripened gold"—as the Indians indigenous to those regions where it was found believed it to be and had planted it back in the river bed to give it more time to ripen into the yellow metal gold. In the Archivo General de Indias in Seville and in the Archivo Historico and Biblioteca Nacional in Madrid, Spain, there are kept the records of the transactions, descriptions and observations in minute detail between these extraordinary colonies and their mother country. There are, in addition, other libraries and private collections in Spain pertaining to the Americas, but it was among the three named that I was engaged upon another problem when I found references to platinum dated 1735. Some of these preserved documents refer to the shipment of rather large quantities (in one case 18 pounds) of alloyed metal which was called platina. In one document mention was made of a refined platinum, which had been treated with mercury prior to its shipment to Spain.

This (1735) is twelve years before don Antonio de Ulloa set out from Spain to make his scientific voyage (to measure meridian) and subsequently write his "Relacion Historica," and I have reason to believe that earlier references exist among this literature.

E. P. C. MEYER

CLEVELAND, OHIO

REPORTS

THE INCORPORATION OF SCIENTIFIC SOCIETIES

AT the Cleveland 1930–31 meeting of the American Society of Plant Physiologists the question as to the advisability of incorporating the society was referred to a committee.

Of the twenty-one scientific societies investigated, fifteen are incorporated. Seven of these societies are incorporated in the District of Columbia, one in Illinois, one in Wisconsin, one in Massachusetts, one in New York and one in Pennsylvania. As the reasons for and ways of incorporating learned organizations may be of interest to other scientific societies the findings of the above committee are here summarized.

The advantages of incorporation are important, inasmuch as it establishes a learned non-profit organization as a legal entity, thus bestowing:

(1) Freedom from financial responsibility in any lawsuit against the members on account of any action of the society.

(2) The ability to hold property and to receive gifts and bequests.

A few scientific societies reported to our committee that incorporation had resulted in the accumulation of funds for research, etc., by giving greater security to endowment funds and thus making it easier for donors to give relatively large gifts and bequests.

The possible disadvantages are related to the freedom of action of the organization. An unincorporated society may do as it chooses, whereas upon incorporation the organization must comply with the laws of the jurisdiction where it is incorporated. Practically, however, the disadvantages resulting from this restraint or freedom of action is regarded by legal authorities as being slight. The statutes of some jurisdictions impose fewer restraints than others and the requirements for headquarters, annual meetings, reports, etc., differ in different jurisdictions.

The procedure of incorporating under the laws of the District of Columbia, and also in certain other jurisdictions, is relatively simple. The statutes of the District of Columbia relating to corporations and of certain other jurisdictions relating to learned *non-profit* organizations neither require a resident director nor the maintenance of an office in the jurisdiction. Meetings may be held anywhere and at any time without restriction.

The principal requirements under the laws of the District of Columbia may be taken as an example of the general procedure: (1) Any three or more persons of full age, citizens of the United States, the majority of whom are citizens of the District of Columbia may incorporate; (2) a certificate in writing must be filed in the office of the Recorder of Deeds stating (a) the name of the society, (b) the term for which it is incorporated, which may be perpetual, (c) the business and objects of the society, (d) the number of its trustees, directors or managers for the first year of the incorporated society's existence.

Upon the execution of the articles of incorporation of the society and the deposit of same with the recorder of deeds, the incorporators then form a temporary organization in Washington, D. C., at which meeting one of their number is elected temporary chairman and another temporary secretary. The constitution and by-laws of the organization as then standing are adopted, and all the then existing members of the society are declared elected members of the corporation with their present rights and privileges. The meeting then adjourns to assemble at the next regular place of meeting of the now incorporated society.

Many of the scientific societies investigated dispensed with legal assistance. Under such conditions the only expense involved is the registration fee of two or three dollars. A few societies, however, obtained advice of counsel in making such changes in their by-laws to conform with the statute under which incorporation is sought. The expense in such cases is about one hundred dollars.

A comprehensive discussion of the business relations of non-profit corporations is given by Harriman in Corporate Practice, Review 1, 7–11, 1929.

Burton E. Livingston
Johns Hopkins University
James B. Overton
University of Wisconsin
Walter Thomas (*chairman*)
Pennsylvania State College

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR DETERMINATION OF CO_2 AND O_2 OF RESPIRATION

In determining the respiration rate of fruit in storage a modification of the apparatus described by Magness and Diehl[1] has been used. The apparatus as modified has proved very satisfactory and is described here in the hope that it may be useful to others interested in respiration rate determinations.

With this apparatus the O_2 consumed as well as the CO_2 evolved can be measured. It consists (Fig. 1) of a water reservoir "A" which is connected by a siphon to a beaker "B" in which the water is maintained at a constant level by means of the siphon feed. The beaker "B" is connected by tubing to a liter-graduated cylinder "C" containing oxygen. The cylinder "C" is connected by capillary tubing to the respiratory chamber "D," which consists of a desiccator with a funnel fitted into the tubulature of the lid and the stem extending down to a second funnel which is fitted into a hole bored through the bottom of the desiccator. The apparatus of Magness and Diehl is modified in that the container for the O_2 is a graduated cylinder instead of a bottle and the beaker for the KOH solution is replaced by the two funnels in the

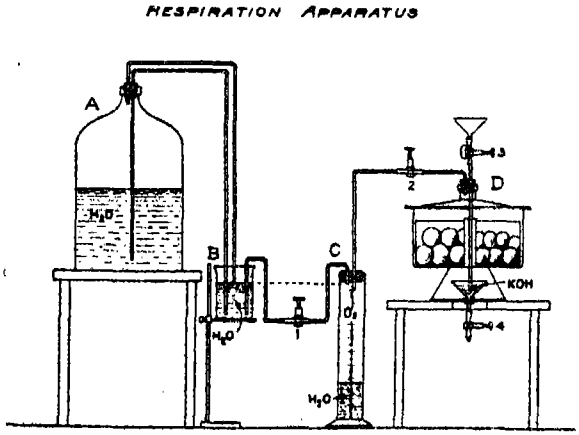

Fig. 1

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[1] J. R. Magness and H. C. Diehl, "Physiological Studies on Apples in Storage," *Jour. Agr. Res.*, 27: 1–38, No. 1, 1924.

desiccator. The use of a graduated cylinder for the O_2 has been previously described by Johnstone[2], but was developed independently by the authors. These changes greatly facilitate the measurement of the O_2 and the changing of the KOH solution and make possible more accurate determinations.

To determine the respiration rate the material to be studied is weighed into a round wire mesh basket that fits into the desiccator. This basket has a tubulature through the center so that when it is placed in the desiccator the stem of the upper funnel can extend down to the lower funnel. After sealing the lid on the desiccator, the upper funnel is fitted into the lid and a solution of twice normal KOH (usually 25 ml) is drained into the lower funnel through the upper funnel and rinsed down with a small quantity (10 ml) of water. The O_2 cylinder is connected to the beaker "B" and the clamp at "1" opened. The desiccator is then connected to the O_2 cylinder and the clamp at "2" opened. The lid must be sealed airtight to the desiccator and all connections must be airtight.

As the material respires, CO_2 is given off and O_2 absorbed. The CO_2 given off is absorbed by the KOH solution in the lower funnel and the O_2 used is replaced by O_2 from the cylinder C. The O_2 withdrawn from C is replaced by water from B. Thus the system remains at atmospheric pressure and the concentration of O_2 and CO_2 in the atmosphere in the respiration chamber remains practically unchanged.

At the end of a run the clamp at "2" is closed and the KOH solution in the lower funnel drained into a flask. The lower funnel is then rinsed into the flask by adding water through the upper funnel. Fresh KOH is added through the upper funnel, the amount of water in the cylinder recorded, the clamp at "2" reopened and the respiration determined continued. The KOH is titrated against standard 2 normal H_2SO_4 to the phenolthalein end point and then to the methyl orange end point and the amount of CO_2 computed from the difference between the two end points. The volume of water drawn into the cylinder represents the amount of O_2 consumed by the material after it has been corrected for changes in barometric pressure during the run, for O_2 and N_2 dissolved in the water and has been converted to standard conditions of pressure and temperature.

The humidity in the respiration chamber may be controlled by placing different concentrations of H_2SO_4 in the bottom of the desiccator around the lower funnel. It is desirable that the size of the sample be so regulated that about 200 to 300 cc of O_2 are used and about a third of the KOH neutralized by the CO_2 evolved during a run. When this is done there is no appreciable accumulation of CO_2 in the respiratory chambers. If about half or more of the KOH is neutralized the phenolthalein end point in the titration becomes indistinct and there is likely to be an accumulation of CO_2 in the respiratory chambers due to the decreased efficiency of the KOH solution. On the other hand, if less than 100 cc of O_2 are used during a 24 hour period, a lowering of the atmospheric pressure of more than .3 inch may cause the gas in the desiccator to expand more than 100 cc and result in a flow of gas from the respiration chamber to the oxygen cylinder.

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VEGETABLE PEPTONE AGARS FOR QUANTITATIVE WORK WITH LACTOBACILLUS ACIDOPHILUS[1]

LACTOBACILLUS ACIDOPHILUS does not grow well on plain nutrient agar. To meet this difficulty, various special media have been suggested from time to time. The most widely used of these are: the whey agar proposed by Rettger and Cheplin,[2] 1912; the galactose agar of Rettger and Kulp,[3] 1922; the casein digest galactose agar of Kulp and Rettger,[4] 1924; the whey peptone galactose agar of Kulp,[5] 1926, and the tomato peptone agar of Kulp,[6] 1927. The third and fourth named are made in the dehydrated form by the Difco Laboratories, Detroit, Mich.

In connection with work on another problem in which we used acidophilus milks made with the "Scav" strain, we amassed considerable quantitative data consisting of a series of parallel counts on galactose whey agar and a cabbage agar which proved very satisfactory.

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[2] G. R. Johnstone, "Physiological Study of Two Varieties of *Ipomoea batata*," *Bot. Gaz.*, 80: 145–167, 1925.

[1] Read at the Baltimore meetings of the Society of American Bacteriologists, Dec., 1931.

[2] L. F. Rettger and H. A. Cheplin, "The Transformation of the Intestinal Flora with Special Reference to the Implantation of *Bacillus acidophilus*," Yale University Press, 1921.

[3] L. F. Rettger and Walter L. Kulp, "A Note on the Choice of Culture Media for the Study of Lactobacillus with Special Reference to the Carbohydrate Employed," *Abs. Bact.* 6, 24, 1922.

[4] W. L. Kulp and L. F. Rettger, "A Comparative Study of *L. acidophilus* and *L. bulgaricus*," *Jr. Bact.*, 9, 357–394, 1924.

[5] W. L. Kulp, "The Determination of Viable *Lactobacillus acidophilus*," SCIENCE, 64, 304–306, 1926.

[6] Walter L. Kulp, "An Agar Medium for Plating *L. acidophilus* and *L. bulgaricus*," SCIENCE, 66, 512–515, 1927.

The cabbage agar was prepared in liter quantities by shredding 250 grams of fresh cabbage, adding one liter of tap water, and boiling for one half hour. The decoction was then decanted off, the loss of water restored, and the liquid filtered through filter paper. To this liquid, ten grams of peptone (Difco), five grams of sodium chloride, two and one half grams of ortho sodium phosphate, and ten grams of Difco agar were added. The mixture was heated in the steamer until the ingredients were in solution. A very clear medium was obtained by sedimentation and removal of detritus by decantation of the clear liquid. This medium was sterilized in the autoclave at fifteen pounds pressure for fifteen minutes. The reaction varied somewhat but the pH was usually about 6.4 which is within the range for the good growth of the Lactobacilli, so that we have not regarded it necessary to adjust the reaction. A few experiments indicate that the sodium orthophosphate may be omitted from the formula without decreasing the value of the medium, and in some other experiments both the phosphate and the peptone have been omitted without decreasing its value as a culture medium.

In the process of plating, the medium was poured directly from bottles or flasks into the Petri dishes, about 16 or 20 cc per plate. When the agar had hardened, the plates were inverted and placed in closed containers and surrounded with an atmosphere of approximately ten per cent. carbon dioxide. The plates were incubated at 40° C. for 48 hours. The excessive amount of water of condensation was absorbed by the use of clay tops or by fitting disks of blotting paper into the tops of the Petri dishes.

A simple microscope, magnifying three and one half times, was used in counting.

The type of colony which appears on cabbage agar shows the rough irregular edge which has been considered characteristic of *L. acidophilus.* On the galactose whey agar there is a tendency for the growth to be compact, while the cabbage agar shows a thinner, somewhat more transparent, and more spreading colony. Although the colonies on the cabbage agar are more transparent, they are easily seen with the naked eye because of their larger size. The first fifty colonies taken at random on each of two plates, which were exact duplicates except for the medium, were measured with an ocular micrometer. The fifty colonies on the whey agar averaged 396 microns in diameter, while the same number on the cabbage agar averaged 531 microns.

Our tabulated quantitative data shows very plainly two interesting trends: first that the cabbage agar counts are higher than the galactose whey agar counts with consistent regularity, and second, that the higher counts on the cabbage agar are especially pronounced on the milks that are from two to three weeks old. Thus in a group of forty-five counts on milks which were from one to seven days old, the ratio of the galactose whey count to the cabbage agar count was as 1:1.55; on milks eight to fourteen days old, the ratio was 1:2.94; on milks sixteen to twenty-one days old, the ratio was 1:2.28, and on milks twenty-two to twenty-eight days old, the ratio was 1:2.17. This may be taken to indicate, it seems to us, that there are substances in the cabbage which stimulate the old bacterial cells in the milk to a vigorous growth, while such substances are lacking in the galactose whey agar. This would seem to be a desirable quality for a medium to possess if it is to be used for controlling a commercial product since it seems fair to assume that similar stimulating substances may exist in the intestinal tract of man. At any rate, the results indicate that many bacteria which are supposedly dead when their viability is tested by seeding in galactose whey agar, are alive and vigorous in our cabbage agar.

The method described for making cabbage agar was used in the preparation of other vegetable agars. Carrots and green beans were used in the same proportions as the cabbage. In tomato and spinach the proportion of the vegetable was doubled. Growth on green bean and spinach agars was very good, yet our data seem to indicate that these two vegetables are slightly less favorable than cabbage. Carrot and tomato agars, on the other hand, gave results very similar to those obtained with cabbage.

Since some milk product has been so generally used in the various media recommended for the growth of *L. acidophilus*, and since we found extracts from various vegetables to be very favorable, it occurred to us that a combination of such materials might be still more favorable. With this in mind, a tryptic casein digest prepared according to the method of Kulp and Rettger,[4] was added to our cabbage agar. With this medium we have obtained on some plates colonies which average twice the size of those on our vegetable media, but in sharpness of definition and in quantitative results, such media appear to offer no advantages over the simple vegetable media.

We believe that our results should recommend the use of a simple vegetable medium for quantitative studies on acidophilus milks because of the ease and simplicity of preparation; because of the characteristic appearance, the sharpness of definition, and size of the colony, and because of the somewhat higher count which is especially marked with the older milks.

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SPECIAL ARTICLES

CURE OF THE CACHEXIA FOLLOWING HYPOPHYSECTOMY BY ADMINISTRATION OF THE GROWTH HORMONE AND ITS RELATION TO THE RESULTING ADRENO-CORTICAL REPAIR[1]

IN 1927, Smith[2] demonstrated that daily intramuscular implants of fresh glandular substance (hypophysis) will repair most,[3] if not all, of the disabilities shown to characterize animals after complete hypophysectomy. The ground was thereby laid for adequate test as to whether extracts of the hypophysis contain one or all of the hormones present in fresh glands. In particular it could be seen, now, whether the growth and gonad-stimulating hormones originally detected by other tests (*i.e.*, their effect on normal mature and immature animals) made up the full complement of anterior hypophyseal hormones, and could therefore completely substitute for the missing gland, and, finally, it should be possible to discover in this way which of the known hormones was responsible for those other features of the syndrome from hypophysectomy besides the disturbance in growth and sex, the deficiency, for instance, in thyroid, parathyroid, and adrenal cortex.

While the administration of extracts, which Evans and Long (1922) had shown to contain the growth hormone, invoked growth in hypophysectomized rats in Smith's hands, he showed clearly that such extracts would not repair the gonadal deficiency, but in fact prevented its repair by implants. He stated that they also did not repair the subnormality of thyroid and adrenal cortex. The present paper reports that the latter result can be accomplished with satisfactory extracts of the growth hormone.

The resumption of growth in hypophysectomized animals following injections of extracts was confirmed by van Dyke. Furthermore, Reichert has shown that the prolonged administration of our growth hormone to completely hypophysectomized puppies produce dogs which exceed in weight and in skeletal dimensions their normal littermate controls. Striking results of this sort have been consistently secured by us. In a long series of experiments on hypophysectomized rats we have administered purified preparations of the growth hormone[4] free from gonad-stimulating effect. The growth rate of hypophysectomized rats receiving these preparations even exceeded that of normal animals receiving the same extracts.

Concerned for some years with the preparation of purified extracts of the growth hormone and more recently with the gonad-stimulating hormone of the hypophysis in order to distinguish their respective rôles or effects, we have applied such extracts to very considerable numbers of hypophysectomized rats. What we desire to place on record in the present communication is the remarkable, prompt and uniform relief from the cachectic state following administration of the growth hormone extracts. Not only is growth resumed, but a rapid and impressive change in the constitutional state of these animals results. This is indicated especially by the resumption of normal turgor to their tissues and above all of normal muscular strength and muscle tone. The myosthenia so characteristic of the hypophysectomized animals disappears within 10 days following the growth hormone therapy. In contrast with these results the administration of even large doses of gonad-stimulating hormone (growth-free) has no influence on the cachexia, even though these products provoke an extreme reaction in the gonads.

The animals injected with growth hormone are indistinguishable from normal animals. Only the genitalia retain the hypophysectomized condition, the glands and accessory organs being atrophic. Autopsy shows repair of both the thyroids and the adrenals. The reparation of the adrenals and thyroids under the influence of growth hormone is, however, not complete. The weights are consistently greater, but do not attain the weight of glands of normal animals. Under the conditions of dosage and time intervals studied thus far, the glands have never attained the weight of those of the normal controls, even when doses are given which stimulate normal or excessive body growth. The gonad-stimulating hormone free of growth hormone, which as stated before has no effect on the cachexia, also does not induce this repair of adrenals or thyroids.

The differences between the histological pictures of the adrenals of hypophysectomized animals and those receiving growth hormone are very striking. In the adrenals of the treated animals the cytoplasm of the cortical cells is restored and three zones become again distinguishable. The gonad-stimulating hormone, on the contrary, produces no such repair in adrenals, even though a dose is administered which causes excessive hypertrophy of the gonads.

The disappearance of the cachectic condition fol-

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[1] From the Institute of Experimental Biology, University of California. Aided by grants from the Committee for Research in Problems of Sex of the National Research Council, and from the Rockefeller Foundation. These funds have been generously augmented by the Board of Research and the College of Agriculture of the University of California.

[2] Smith, P. E., *Jour. Amer. Med. Assn.*, 88, 158 (1927).

[3] Normal gestation in the hypophysectomized female was not secured.

[4] These are essentially solutions of the acetone precipitate of the Evans-Simpson-Cornish Extract; see Evans-Simpson-Cornish, *Proc. Soc. Expt. Biol. and Med.*, 1930.

lowing the administration of the growth hormone parallels the repair of the adrenals. It is quite probable that the cachectic state and the atrophy of the adrenals are causally interrelated and that it is to the change in the adrenal following administration of the growth hormone that we must refer the remarkable general constitutional restoration. Experiments are now under way to see whether the cachectic symptoms following hypophysectomy can be relieved, although growth is not induced, by injections of adrenal cortical extracts.

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THE TRANSFORMATION OF SERUM ALBUMIN INTO SERUM GLOBULINS[1]

The antiprothrombin (heparin of Howell) forms with protein complex compounds which show different properties according to the amount of heparin bound to the protein molecule.

The heparin combines with the organic complex of the protein and by means of its affinity for water (lyophil action) increases the solubility of the proteins. The antiprothrombin gives the protein an electronegative charge and moves its isoelectric point towards the acid side.

By adding heparin to pure globulin fraction in salt solution one is able to move the isoelectric point, which for globulins is normally around pH 5.0, towards the acid side; the range depends upon the concentration of the heparin. As is well known, the serum albumin does not flocculate at its isoelectric point. If heparin is added to serum albumin (at pH 5.0), which is freed from globulins by means of dialysis, a flocculation immediately takes place. The degree of flocculation depends only upon the amount of heparin added when excess albumin is present. Albumin-heparin compounds behave as genuine globulins, and we are justified in considering them as identical with the globulins. (Solubility, precipitation by means of weak acids, denaturation, precipitation by means of salts, solubility in heparin (in excess) dialysis, isoelectric point.)

Experiments on quantitative dialysis of whole serum show that the addition of small amounts of heparin results in an increased amount of globulin (determined by weighing).

The antiprothrombin is so far the only substance normally found in the body (the urea does not play any rôle in this connection), having the powerful action described, which is responsible for the formation of the globulins. We found that the amount of globulins present in blood serum is a direct expression of the amount of antiprothrombin. The coagulability of a plasma depends entirely upon the amount of globulins present. By means of the method to isolate the heparin as indicated by Howell, much greater amounts of heparin could be isolated from blood in which the amount of globulin was greater than from any other serums.

From the purified casein (*Hammarsten*) which behaves as a globulin and especially towards heparin, we were able to isolate a heparin-like principle of high activity, if not heparin itself.

Fibrinogen belongs to the globulins. According to the amount of heparin bound to the protein molecule, it is possible to place the various globulins in a certain system. When the various fractions of the serum proteins are precipitated in a buffer system of pH 5.0 as a function of the heparin concentration, the relative charge of heparin on the definite protein fraction may be determined. Heparin acts on the principle of the "unregelmässige Reihe," that is, greater amounts inhibit and smaller promote the flocculation.

The euglobulin goes into solution with a small amount of heparin; the pseudoglobulin needs a larger amount of heparin than the euglobulin for solution. The fibrinogen needs an even greater amount of heparin before it is dissolved. If we consider the serum albumin as heparin free, the other protein fractions of the plasma come as follows: fibrinogen, pseudoglobulin, euglobulin. Our experiments show that the euglobulin fraction is immediately formed when heparin is added to pure serum albumin. We suppose that there exist just as many protein compounds in blood as there are possibilities for heparin-albumin compounds. It is conceivable that the various compounds are dissociated according to the principle of the dissociation of the pluribasic acids. There are just as many dissociation steps as there are possibilities for heparin-albumin compounds, each with its own dissociation constant. This consideration agrees very well with the modern conception (*Sörensen*) which considers the proteins as reversible dissociable systems of components.

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[1] From the Kaiser Wilhelm-Institut für Biologie, Gastabteilung.

PERIODICAL PROPERTIES OF ATOMIC NUCLEI

According to our present knowledge of the structure of atoms, there is no reason to expect *a priori* the existence of a simple relation between the electron coverings of an atom and the internal constitution of the nucleus.

Therefore some experimental facts showing such a relation must be of interest. These facts have a statistical character. It is only possible after the investigation of much experimental material to point out the following regularities.

It is well known that the number of nuclear electrons is not a simple function of the atomic weight. There are many isotopes of different elements having the same atomic weight, but different numbers of nuclear electrons.

The number of isotopes having the same atomic weight, N, can be regarded as a function of this atomic weight. Curve 1 in Fig. 1 represents such a function.

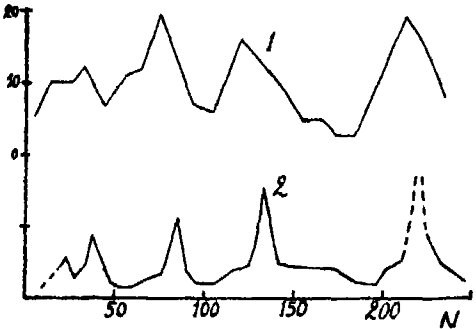

FIG. 1

Each point represents a mean value for an interval of ten atomic weights. It is easy to recognize the periodical character of this curve. It may also be pointed out that the periods correspond to those of the periodical system of the elements. This can be seen comparing curve 1 with curve 2 in Fig. 1. Curve 2 shows also the atomic volume as a function of the atomic weight.

The number of isotopes having the same atomic weight is determined by the properties of the nuclei. On the other hand the atomic volume is determined by the properties of electron coverings of the atom. If we have in both cases the same periodicity we must have also a connection between the outer electrons and the protons and electrons in the nucleus.

There is also another fact showing the same relation. It is known that generally elements having even atomic numbers exist in larger quantities than elements with odd numbers (Harkins' law). This fact can be explained by the greater stability of nuclei with even atomic numbers. Let n_1 be the relative quantity of a given element with an odd number and n_2 the quantity of the next one with an even number. The value

$$E = \lg h_1 - \lg h_2 = \lg \frac{n_1}{n_2}$$

can be regarded as a function of the atomic number 7. Taking experimental material from a work of I and W. Noddak[1] it is possible to receive a curve illustrating this function and shown in Fig. 2 (curve 1). This curve can be compared also with the curve of atomic volumes. (Fig. 2, curve 2).

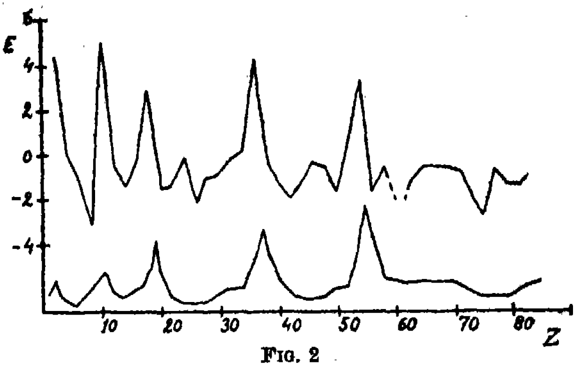

FIG. 2

All the described facts show the existence of some connection between the nucleus and its electron covering. It seems to be probable that quantum laws can be applied not only to the electron covering but also to the nucelus of the atom.

Assuming, (1) that atomic nuclei having the same geometrical structure must have also the same physical properties, (2) that the volumes of nuclei are proportional to the numbers of protons and (3) the protons can not be deformed in the nucleus, it is easy to show that only such nuclei can have the same form as a proton, which have the following atomic weights:

$$N_1 = 1 = 1^3$$
$$N_2 = 8 = 2^3$$
$$N_3 = 27 = 3^3$$
$$N_4 = 64 = 4^3$$
$$N_5 = 125 = 5^3$$
$$N_6 = 216 = 6^3$$

Therefore the atomic nuclei with given values of N must have analogical physical properties. We obtain therefore a periodical system of nuclei, each period limited by N_1, N_2, etc. This is in good agreement with the experimental facts shown in Fig. 1 and Fig. 2.

It is possible also to receive an analogical result from the standpoint of wave mechanics. A more detailed discussion of this possibility will be given in another place.

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ALLUNION ELECTROTECHNICAL INSTITUTE,
MOSCOW 33—AUGUST, 1931

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[1] *Naturwissenschaften*, 18, 757, 1930.

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SCIENCE

Vol. 75 Friday, April 29, 1932 No. 1948

Experimental Epidemiology: Dr. Leslie T. Webster 445

Obituary:
Louis Agricola Bauer (1865–1932): J. A. F. *Wilhelm Ostwald:* Professor Wilder D. Bancroft. *Recent Deaths* 452

Scientific Events:
The International Congress of Mathematicians; Zoological Sessions at the Summer Meeting of the Association; Award of the Osborne Medal to Dr. C. H. Bailey; The American Philosophical Society 455

Scientific Notes and News 457

Discussion:
The Field Naturalist in the Final Interpretations of Life: H. A. Allard. *Spontaneous Combustion in the Marshes of Southern Louisiana:* Percy Viosca, Jr. *Rhythmic Phenomena in Gels:* J. M. Johlin. *Behaviorism in Science:* Professor William D. Tait 460

Quotations:
International Cooperation 463

Scientific Apparatus and Laboratory Methods:
Influence of Method of Shaking on Amount of Phosphate Dissolved from Soil by Water: Professor P. L. Hibbard. *A Method of Artificially Feeding the Sugar-beet Leafhopper:* J. M. Fife 464

Special Articles:
Visual Purple in Snakes: Dr. Gordon L. Walls. *A Note on the Flow of Fluids through Porous Media:* Dr. George H. Fancher and James A. Lewis 467

Science News 10

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EXPERIMENTAL EPIDEMIOLOGY[1]

By Dr. LESLIE T. WEBSTER

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Epidemiology, according to common usage, is knowledge of the mode of spread of infectious diseases. This knowledge is especially concerned with epidemics and endemics, long-time and short-time cycles of disease prevalence, general and local extension of disease and relative severity of disease in racial and familial groups and in individuals. Data, mostly descriptive and poorly organized, accumulating for centuries, were simplified in part by experimental pathologists and bacteriologists at the close of the nineteenth century into several principles, a postulate and a theory.

Considered chronologically, the first two principles are the communicability of certain diseases and the living specific nature of their known incitants. This knowledge was present in substance 4,000 years ago in popular superstitions and beliefs but was not established on an experimental basis until Bassi transmitted silkworm muscardine in 1835, Remak transmitted favus in 1840, and Brauell, Pasteur, and Koch transmitted anthrax in 1857 to 1890. Three additional principles, namely, the operation of host resistance, diet and climatic factors influencing the spread of infectious disease, were likewise recognized from earliest times, but are only recently being studied experimentally. The last two, the doctrines of the carrier state and of specific immunity, established by Koch and by Behring and Kitasato, respectively, are modern both in concept and experimental proof.

Knowledge of infection underwent further organization during the Pasteur-Koch period. Theurgical and supernatural doctrines of epidemics were discarded, and the possible effects of cosmic, constitutional and subsoil influences came to be ignored. In their places a postulate was made by students of descriptive epidemiology, that all phenomena of infection can be accounted for in terms of three factors—virulence of the specific agent, dosage of the agent available to the host and resistance of the host to the specific agent. This postulate has since been accepted by the majority of epidemiologists.

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[1] Cutter Lecture on Preventive Medicine, 1932. Harvard University.

Strangely enough, however, except for the studies of Theobald Smith and of plant pathologists, few efforts have been made to test the postulate experimentally, or to analyze the mode of operation of the hypothecated microbic and host factors. The descriptive epidemiologist is working with vital statistics which contain uncontrolled sources of error, the bacteriologist is studying the problem of microbic virulence in artificial infections and in artificial media, without determining whether his findings are in any way related to the behavior of microorganisms in their native host, and the immunologist is gaining knowledge of the specific substances found in the blood of individuals who have been exposed to an antigen, but is slow to investigate the extent to which these specific substances are related to the resistance of the host under natural conditions.

The postulate of the rôle of parasite-host factors was, in spite of the lack of experimental testing, further simplified by bacteriologists and immunologists into a theory that the spread of infectious disease is determined in the main by fluctuations in virulence of the specific agent and fluctuations in the specific acquired immunity of the host. This prevailing view has of late, however, been subjected to much criticism. Some investigators urge that bacteriology alone does not explain all the mass phenomena of epidemics and consequently that unknown forces should be given further consideration. Others believe that more attention should be paid to the demonstrable phenomena of host, climate and dietary influences. Increasing numbers regard epidemiology as not reducible to bacteriology and immunology alone, and demand a type of investigation which deals with conditions more closely similar to those in nature.

To meet this need, a new field of research has been developed. Shortly after the influenza pandemic of 1918–1919, investigations were commenced by Topley in London and by Flexner and Amoss in New York, to determine experimentally the general mechanisms underlying the spread of infectious disease. These studies, continued and amplified by others in the past eleven years, have come to be regarded as a definite discipline—experimental epidemiology.

This discipline is far-reaching in scope. It affords a means of acquiring relevant and at the same time controlled data on the spread of one or a number of animal infections. It affords a hope that this sort of information of a number of infections in a number of species of native hosts may be simplified into a theory which will describe a part of the epidemiology of animal and of human infections as well.

The technique of experimental epidemiology has been to study the mode of spread of native infections among populations of laboratory animals. Thus far a total of nine enteric and respiratory infections of rodents and fowls has been analyzed by observations both on population infections occurring spontaneously, and induced experimentally, and by measurements of virulence, dosage and host resistance, especially during the actual spread of infection. The technique has been put to use in two different ways. Topley and Greenwood experiment with *aertrycke* infection of mice chiefly to throw light directly on the perplexing questions of human epidemiology; we, on the other hand, study the spread of an animal infection as an end in itself and extend the study to different native infections in different host species with a view to building up an experimental science. The details of the technique have differed according to the emphasis placed upon control of variables and adherence to natural conditions. Some investigators have made relatively few efforts in their experiments to control host variables and in many instances to reproduce natural conditions. Their efforts have rather taken the direction of attempting to interpret data by subjecting them to the ordinary analyses used in the study of vital statistics.

It is to be assumed, however, that since one or many factors may conceivably influence the spread of infection, the greatest possible control of all is to be desired. Therefore, in recent experiments at the Rockefeller Institute every effort has been made to control not only the microbic but especially the host variables. The animals employed are born and raised in special breeding rooms on the premises. Their heredity, age and weight are known; their allotted space, cleaning routine, food, temperature and light are kept uniform. The animals are known to have been free of any previous exposure to the given infection. Finally, when microbic virulence, dosage and host resistance factors are being analyzed, it is to be assumed that a technique reproducing natural conditions in the greatest degree is most apt to yield results which are applicable to the phenomena of natural infection. Hence, in the institute laboratories the specific bacteria are introduced into the native hosts not by intraperitoneal injection but by way of the normal portal of entry. These procedures give results which reproduce events in nature and which at the same time are quantitative.

Early experiments showed that natural infection could be established in susceptible populations by administering pure cultures of specific bacteria to constituents or immigrants. Amoss, in 1922, fed mouse typhoid cultures to ten mice and placed them in two cages in the midst of 100 normal mice in twenty cages. Shortly thereafter, the specific infection was fatal to eight of the original mice and spread to the normal animals. Later, four batches of mice were added and the infection extended to each group in turn. Recently Friedländer pneumonia was established in four populations of mice in our laboratory by administering 500 bacilli intranasally to certain constituents—in one experiment the entire group received the organisms and normal immigrants were added thereafter at the rate of two per day for three and a half years; in two further experiments three groups of 100 mice each received six immigrant mice which had been given 500 Friedländer bacilli intranasally. Healthy immigrants were added thereafter for two and a half years and eight months, respectively. In each case the Friedländer infection spread from the immigrants to the healthy population and became established with endemic and epidemic phases identical with those of the spontaneous disease.

Early experiments likewise showed that epidemics could be induced in populations under two definite sets of conditions. First, in previously unexposed communities, by administering to each individual a certain dose of the specific organisms by way of the natural portal of entry, and second, in already infected populations, by adding susceptible immigrants. Epidemics of mouse typhoid were incited in previously unexposed populations by administering three to five million bacilli in broth intrastomachally to batches of 20 to 100 mice. The resulting mortality over a sixty-day period in averaged tests was characteristic and practically identical with that occurring during spontaneous epidemics. Epidemics of Friedländer pneumonia were incited in previously unexposed populations by administering 500 bacilli in broth intranasally to batches of 50 to 100 mice. The resulting mortality over a thirty-day period was uniform in averaged tests and similar to that occurring during spontaneous epidemics. In infected populations, outbreaks of mouse typhoid were incited by adding batches of normal susceptible immigrants. Following some suggestive observations of Topley in 1919, Amoss assembled 100 healthy mice in twenty cages of five mice each and midway placed two additional cages of five mice each, which had been fed on a culture of mouse typhoid bacilli. Four weeks later forty additional cages, containing five mice each, were placed near the first batch. Subsequently, sporadic infection occurred, fatal in three months to about 50 per cent. of the population. The survivors were recruited to their original numbers by replacements in each cage to five mice. Within a few days an epidemic of mouse typhoid occurred, fatal to 70 per cent. of the herd in two months. A second and third replacement was made, followed by outbreaks of decreasing severity. These results were confirmed in 1925 by Greenwood and Topley, who showed that the repeated addition of normal individuals to mouse populations infected with Pasteurella is followed by recurring epidemic waves. Likewise, experiments at the Rockefeller Institute in 1930 showed that if immigrants were added to one of three mouse populations infected with *B. friedländeri*, recurrent epidemics of pneumonia ensued, while if at the same time and under identical conditions, immigrations were discontinued in two remaining populations, no epidemics occurred and the infection died out.

Topley and Greenwood, in further observations on infected mouse populations, emphasized the close association between the amount of mortality and the number of susceptible immigrants. They found that when mice were added to an infected herd at a constant rate, the mortality was propagated in regularly recurring waves and suggested that the character of the waves was dependent upon the rate of addition of immigrants. We observed later that when four or more populations of mice infected with *B. friedländeri* were recruited at the rate of two mice per day, the primary epidemic waves of pneumonia occurred when the population had reached a certain level, lasted a definite number of days, and reduced the population census to a definite low level. Moreover, when *B. enteritidis* typhoid was spreading under identical conditions in uncomplicated form in these communities, the mortality waves occurred with considerable regularity at nine to eleven day intervals. It is concluded, therefore, that epidemics may be incited in already infected herds by the proper addition of susceptible immigrants, and in unexposed populations by administering to each individual a certain dose of the specific organisms.

Early in these studies, Topley observed that, following epidemics of mouse typhoid there are a certain number of survivors and stated that these survivors are both potentially infective and relatively immune. Evidence of the immunity of survivors was obtained later in our laboratory by actually comparing the resistance of surviving and non-exposed mice. Mouse typhoid organisms were administered by mouth to 100 individuals; sixty days later there were thirty-two survivors. These together with twenty normal, unexposed mice, were then given a similar dose of bacteria. Sixty days later, 30 per cent. of the survivor group had succumbed, as compared to 80 per cent. of the control group, showing that by actual test survivors are more resistant than non-exposed animals to the given infection.

The results thus far described demonstrate that various endemic and epidemic phenomena of natural enteric and respiratory infections may be reproduced experimentally solely by the proper bringing together of susceptible hosts and pathogenic microorganisms, thus furnishing experimental evidence for the postulate brought forward by followers of the Pasteur-Koch school fifty years ago. The second accomplishment of these experiments has been to afford an opportunity for analyzing the microbic and host factors under natural and yet controlled conditions, that is, to determine whether virulence does vary during epidemics and whether epidemics are brought to an end by the population acquiring a specific immunity.

Attention will be first given to the virulence factor. That the virulence of a microorganism, that is, its capacity to harm its native host, is a highly labile variable is an assumption founded upon the early observations of Davaine and Pasteur. This idea, supported later by bacteriologists, has come to form the basis of modern epidemic theory. The experimental epidemiologist, however, recognizing that the data are derived from tests which are now regarded as inadequate, has interested himself in the potency of bacteria under conditions as nearly natural as possible.

One series of tests showed that typical strains of organisms from infected animals were of uniform virulence, whether recovered early or late in the course of disease. For example, each of two cultures of mouse typhoid organisms were given intrastomachally to twenty mice, one from the heart's blood of an animal dying five days after exposure to mouse typhoid; the other from the tail vein of a mouse with septicemia, surviving the infection for five weeks. The acute septicemic culture proved fatal to fourteen; the chronic septicemic culture to twelve mice.

Other tests showed that strains of mouse typhoid, Friedländer and fowl cholera organisms from healthy carriers were in general of the same virulence as strains recovered from fatal cases. Thus, each of three strains of *aertrycke* mouse typhoid organisms was given by mouth to twenty mice, one a culture from an acute septicemic case, two others from stools of two mice surviving and healthy five weeks after exposure. The mortalities were 70, 70 and 65 per cent., respectively. Tests with *B. enteritidis* mouse typhoid gave similar results. Several strains of mouse Friedländer organisms were administered intranasally to batches of fifty or 100 mice in comparable doses. In one instance, a lung culture from a fatal case was compared with a culture obtained from a healthy carrier. Each was given to 100 mice intranasally. The resulting mortalities were 70 and 65 per cent., respectively. Tests were made with thirty fowl cholera strains from fatal cases and forty strains from healthy carrier fowl on several commercial farms. Each strain was administered into the nasal cleft of twenty specially bred young birds. In general, strains from fatal cases proved to be of the same virulence as similar strains from healthy carriers.

Further experiments indicated that strains of specific organisms recovered from populations at various endemic and epidemic periods of spontaneous infection were of uniform virulence. Epidemics of fowl cholera and rabbit-snuffles pneumonia, mouse typhoid and mouse pneumonia were studied in our laboratory, epidemics of guinea-pig and rabbit Pasteurella and pneumococcus pneumonia by Neufeld in Berlin, and epidemics of guinea-pig typhoid by Theobald Smith at Princeton. In no instance were significant differences in the virulence of pre-epidemic, epidemic and post-epidemic strains detected.

Still other tests showed that strains of the same organisms from different populations may differ in virulence and in general that the strains with high potency for killing the native host possessed relatively little ability to vegetate in the tissues of survivors and *vice versa*. This latter relationship is illustrated by experiments in which an epidemic or endemic strain of fowl cholera organisms was administered intranasally to young chickens and permitted to spread to healthy contacts. The tendency of the epidemic strain to kill but not to spread, in contrast to the tendency of the endemic strain to spread but not to kill, was consistent. The same differences were demonstrable with epidemic and endemic strains of rabbit Pasteurella.

One further series of tests may be mentioned briefly—namely, those of the effect of animal passage on virulence. Since the early days of bacteriology, cultures have been transferred from animal to animal for the purpose of enhancing their virulence. The tests have been made for the most part in some foreign animal host and by means of some artificial method, such as intraperitoneal injection, and the results, although definite in a few instances, have usually proved equivocal. Nevertheless, they have been employed to support the idea that prior to an epidemic the virulence of the specific agent increases by means of passage from host to host. The present tests were made under conditions as nearly natural as possible. Mouse typhoid organisms from heart's blood or intestinal contents of animals in the acute stages of infection were given intrastomachally to batches of mice without intermediate cultivation on artificial media. Such passages were made serially and repeatedly. Similar tests were made with Pasteurella cultures native to rabbits, and fowl cholera organisms native to chickens. In no instance was a significant increase in virulence demonstrable.

In summary, the effective virulence of a given strain of microorganisms, when analyzed under natural and controlled conditions, has proved to be a relatively stable property and to some extent inversely related to its ability to survive in the tissues of its natural host. The virulence of numbers of strains of the same organism in the same community was uniform, while the virulence of strains from different communities was at times dissimilar.

The second epidemic factor to be analyzed was microbic dosage—the number of organisms available to the individual host or to the total population at a given time. The findings may be summarized as follows. Changes in dosage exerted a direct effect upon mortality, when virulence and resistance were constant. As dosage was increased, there ensued a progressive increase in percentage mortality up to a point less than 100 per cent. Thus, in a titration of mouse Friedländer bacilli, each of eight doses of the organisms given intranasally to twenty-five mice resulted in mortalities of 32, 44, 56, 64, 88, 96 and 96 per cent., respectively. The second finding has been referred to before, namely, that by giving mice proper doses of typhoid or Friedländer organisms, it is possible to reproduce closely the events of explosive, spontaneous epidemics. Finally, it will be pointed out in tests referred to later that during the actual spread of infection in populations, dosage increased prior to epidemics and decreased prior to their decline by a time interval which approximated that of the incubation period of the infection.

Host resistance, the third epidemic factor, was found to be made up of both non-specific and specific components. The non-specific component was present in definite amounts in breeds or races of animals. For example, monthly tests of the resistance of an inbred strain of mice to mouse typhoid organisms were made from 1922 to 1926. The results in terms of mortality were averaged each year and found to approximate each other within 2 or 3 per cent. Similar tests with other enteric and with respiratory infections and tests with other strains of mice gave similar results. The non-specific components of resistance were present in different amounts in different races or breeds. Thus, a black Lathrop strain, pen inbred for twelve generations, proved on nineteen consecutive monthly tests with *B. aertrycke* and several consecutive tests with *B. enteritidis* mouse typhoid to be more susceptible than the Rockefeller Institute mice. Albino Swiss strain mice, also highly inbred, and albino Rockefeller Institute mice were raised on four different diets. In each case the Swiss mice proved more susceptible. Repeated tests with white-faced and black and tan strains, brother and sister inbred, showed them to be more susceptible than the Rockefeller Institute line.

The non-specific component of resistance was also proved to be present in different amounts in individuals of the same breed. Thus, whenever a controlled group of animals is given a definite dose of some harmful agent, such as $HgCl_2$, individuals show markedly different types of response, ranging from death after the briefest interval to a complete refractory state. Again, whenever a group of animals without previous exposure was given a native infection by the normal portal of entry, individuals showed markedly different types of response, ranging from death after the briefest incubation period to a complete refractory state. These differences were the more regular and predictable when every precaution had been taken to insure uniformity of inheritance, environmental conditions and food. In *B. aertrycke* mouse typhoid, for example, when groups of mice were given bacilli intrastomachally, 70 per cent. died with positive blood cultures in a period of five to sixty days, while 30 per cent. survived. Of these latter, about 10 per cent. were recovered cases, with positive agglutinins, while 20 per cent. showed no evidence of infection. Again, when rabbits were given a similar dose of Pasteurella intranasally, 28 per cent. died of pneumonia, of acute interstitial, lobar, or chronic empyema types, 44 per cent. showed merely local rhinitis or sinusitis, 13 per cent. became healthy carriers, and 14 per cent. remained uninfected. Similar quantitative effects followed the administration of fowl cholera organisms to chickens. These findings have been confirmed by workers in Neufeld's laboratory in their studies of Friedländer and pneumococcus infections of mice. In short, individuals submitted to precisely the same risk of infection, under identical conditions, where every known factor was controlled, exhibited profound differences in response.

That these differences in the reaction of individuals are due to amounts of non-specific resistance which are inherited was shown by the results of tests on survivors and by breeding experiments. Thus, mice surviving an intrastomachal instillation of mouse typhoid organisms proved more resistant to an instillation of mercury bichloride than normal mice. Most significant, however, is the fact that the progeny of mice surviving *aertrycke* or *enteritidis* typhoid were more resistant to subsequent infection with mouse typhoid bacilli or to doses of mercury bichloride than normal, unselected mice; and conversely, progeny of mice, succumbing early to typhoid, were more susceptible than unselected mice. A further study of the inheritance of different degrees of susceptibility is now in progress. Five hundred female and one hundred male mice of the Rockefeller Institute strain were mated, one male to five females. When the young were weaned, the six hundred parents were given intrastomachally three million *enteritidis* mouse typhoid bacilli. In cases in which both parents died within ten days after infection and in which, on the other hand, both parents survived sixty days, the respective litters from susceptible and resistant parents were saved for further breeding. Simultaneous tests of resistance have since been made on progeny of six generations of the original susceptible and resistant group together with an unselected control group. The possibility of specific immunity developing from infected animals was definitely ruled out by repeated carrier and autopsy tests, by testing the population for carriers, by testing animals found dead for mouse typhoid organisms, and by housing the progeny of susceptible and resistant lines together in the same cage for four weeks. The stock has remained free of all infection. Thus far, five lines of susceptible mice and six lines of resistant mice have been selected. The susceptible lines show approximately 95 per cent. mortality within fifteen days after exposure; the control group shows 35 to 40 per cent., and the resistant lines show approximately 5 per cent. mortality over the sixty-day period of observation. The same relationship holds when the resistant mice are given ten times the dose and the susceptible mice 1/100 of the standard dose. The final and necessary test of the resistance of these mice was their response to exposure to spontaneous infection. Cages were arranged to contain five unselected mice given five million *B. enteritidis* per os, together with five normal mice from the susceptible lines and five from the resistant lines. In each instance, all or nearly all the contact susceptible mice contracted the infection and died, while all or nearly all the resistant mice survived and remained healthy. These results prove that of five hundred individuals selected at random, some possess a greater and some a less amount of resistance to *B. enteritidis*, which is transmitted quantitatively to their progeny.

Non-specific components of resistance, besides being inherited, are affected by environmental factors such as season and diet. Thus, each month over a period of years, batches of 50 to 100 mice have been given mouse typhoid or Friedländer organisms with the result that mortalities, although irregular, have been definitely greater during the winter than the summer seasons. Again, mice raised on various adequate diets differed markedly in resistance. One diet containing bread and milk has sufficed to raise the Rockefeller Institute stock and about one thousand progeny per month for more than fifteen years. The fertility, duration of life, weight, appearance and general health of these animals are excellent and have become standard. Another diet used by McCollum has proved adequate for his rodent stock, and a third, a modified Steenbock ration, has likewise proved satisfactory. And yet, mice raised on the bread and milk diet are far more susceptible to *enteritidis* and *aertrycke* mouse typhoid, botulinus toxin and mercury bichloride poisoning than mice fed on McCollum or Steenbock formulae. No intensive efforts have been made thus far to analyze these differences beyond demonstrating that butter fat and cod-liver oil added to the bread and milk changed the "susceptible" into a relatively "resistant" diet. Environmental factors, other than those tested, such as exercise, fatigue and exposure, probably exert some influence on the resistance mechanism of the host, but as yet have not been submitted to adequate tests.

The known specific components of resistance appear to be acquired as a result of contact with the specific agent. Just how potent these specific components may be and how important epidemiologically they may prove has not been determined. Perhaps the most complete test of these questions has been reported by Topley and Greenwood. Animals were vaccinated with killed cultures of *B. aertrycke* and exposed to infection by being placed in an infected population. The amount of protection conferred was claimed to be significant only when a certain type of flagellar vaccine was employed, and then only when the exposure was mild and of brief duration. The protection was not a permanent one; it was noted during periods of about ten to thirty days after exposure.

Thus far, the analyses of host resistance to infection have shown that individual animals exhibit definite amounts of non-specific inherited resistance to primary infection which take the form of a frequency distribution characteristic of the breed or race. Moreover, this resistance may be added to or detracted from by environmental influences, such as season and diet, and may be supplemented by specific immunity components acquired as a result of contact with the specific microbic agent.

The effect of the resistance factor on the spread of infection proved to be important. In the first place, when individuals of a group were given the same dose of organisms of a certain virulence, they died at varying intervals depending upon individual differences in non-specific resistance. Moreover, when a similar group suffered a spontaneous epidemic under controlled conditions, they died at intervals similar to those in the experimental group, indicating that in both instances the form of the epidemic curve was probably controlled largely by the same factors, namely, differences in individual resistance to a large dose of organisms of stable virulence. In the second place, it became apparent that the prevalence of these infections in controlled communities was determined to a great extent by variations in population resistance.

The rôle of resistance and of virulence and dosage as well in actually inciting epidemics was studied in rabbit and fowl populations infected with Pasteurella and in mouse populations infected with Friedländer and *enteritidis* organisms. As the events in all communities were similar, the present description will be confined to those occurring in the mouse herds.

Mice constituting each population were assembled in single large cages and maintained on the routine diet of bread and milk. To each population two normal mice with identification marks were added daily. A census was kept each day and the animals found dead were removed, autopsied and cultured for the presence of the specific organism.

The first experiment was made to test the mode of spread of Pasteurella in communities previously unexposed to these organisms. Populations 1, 3 and 4 received rabbit strains; Population 2 a fowl strain. The three rabbit strains infected few of the mice and died out at once; the fowl strain behaved in quite a different manner. Eight of the ten mice originally fed died within two weeks with Pasteurella septicemia, after which no further deaths from this infection occurred for six weeks. At that time, however, one of the immigrants succumbed. Three weeks later, when the population numbered 61 individuals, explosive epidemics of Pasteurella arose, fatal to 77 per cent. of the population in five days. The epidemic then ceased abruptly and Pasteurella disappeared from the community. The virulence of strains obtained during the epidemic proved to be uniform and similar to that of the culture originally introduced into the community.

The next experiments dealt with explosive and highly fatal epidemics of Friedländer pneumonia which appeared spontaneously in the mouse populations. In the communities to which daily immigrations of two mice were discontinued, the infection died out; in the communities to which daily additions were continued, characteristic secondary waves ensued. These waves appeared when the population census reached a certain level. They lasted a relatively similar number of days and reduced the population to a similar low census. Subsequently, endemic periods intervened, followed by the disappearance of the disease in the late winter. During the next summer, epidemics broke out again similar in each population but more protracted than the previous ones. Fewer secondary waves ensued and the disease disappeared sooner. The virulence of the Friedländer organisms, as determined by their ability to spread and incite typical epidemics, in herds of previously unexposed mice, and by direct inoculation titrations during pre-epidemic, epidemic, post-epidemic and inter-epidemic phases of the infection, proved to be constant. The carrier rate increased prior to epidemic outbreaks and decreased shortly before the time of peak mortality. A substitution of relatively susceptible for standard immigrants in a given population was followed by an increase in severity and frequency of epidemics, while a reverse substitution of resistant for susceptible immigrants was followed by a fall in the severity of the infection.

The final experiments were made with *enteritidis* mouse typhoid in the same mouse populations. The infection took the form of periods of low-grade mortality, interspersed with epidemiform outbreaks. The daily deaths in the one case were either relatively constant or rhythmic in nine-day intervals; the sudden increases in mortality were invariably associated with some definite environmental disturbance. Cultures of the organisms taken from healthy carriers or mice dead of typhoid during pre-epidemic, epidemic or inter-epidemic phases of infection were of uniform pathogenicity. Furthermore, the bacterial dissociation and bacteriophage phenomena, although abundantly present, seemed to play no part in determining the spread of infection. The dosage of the organisms available to the population increased just prior to an increase in death rate and decreased in like manner before a fall in death rate. Most important were the experiments made to test the effect of changing population resistance on the prevalence of infection. Increasing population resistance by substituting an optimum for a barely adequate diet or by substituting relatively resistant for susceptible immigrants each day inaugurated periods of relatively low death rate; on the contrary, a depression of population resistance by substituting the barely adequate for the optimum diet, or the susceptible for the resistant immigrants was followed by severe epidemic outbreaks.

This concludes the present findings in experimental epidemiology. It has been noted that various phenomena of population infection can be reproduced experimentally by the proper bringing together of host and microbic factors. In these native infections, spontaneous or experimentally induced, the virulence of strains of microorganisms from different populations was occasionally different—the more virulent being the less vegetative—but the effective virulence of strains in any one community proved stable during the entire endemic and epidemic periods of observation. The dosage and host resistance factors, *on the contrary, varied significantly* with the amount and severity of infection. Expressing these relationships in terms of cause and effect, it appears that infections in these animal populations were controlled by stable virulence and varying dosage and resistance factors. In instances in which a foreign microorganism gained access to a hitherto unexposed population, the inherent virulence, the available dosage and the amount and distribution of non-specific population resistance together determined the extent and severity of the infection. In instances in which a microorganism was already present in the population, variations in population resistance and in *available* dosage were *chiefly responsible for* endemic and epidemic prevalences. Fluctuations in population resistance were brought about by immigration, season and diet acting upon the non-specific components, and by the infecting agent stimulating the specific components of resistance. Fluctuations in available dosage resulted from variations in the host resistance and vector factors.

To what extent is this knowledge obtained by experiment consistent with the known facts of human epidemiology? Briefly, there is evidence that the factors related to microbe and host suffice to account for the usual manifestations of cholera, typhoid and the *insect and animal-borne infections*; there are no data indicating that these factors may not likewise suffice in other human infections. Concerning the operation of these factors, there are grounds supporting the view that infections transmitted by vectors or contracted from foreign hosts, and infections transmitted by water, milk or food are for the most part controlled by a fluctuating dosage factor operating on a population of fluctuating resistance. These diseases, taken together and considered from the tempero-geographical view-point, constitute the great majority of the total number. Added to them are the parasitic and skin infections, whose prevalence appears likewise to be controlled by the host and dosage factors. The remaining group of respiratory diseases transmitted by direct contact, relatively very small but common to this climate, and therefore of great interest, are at present not as well understood. One can but state that the available data do not discredit the view that their prevalence too is controlled by fluctuations in dosage of and resistance to specific agents of relatively fixed virulence.

Further knowledge of the spread of human infections is being obtained by methods similar to those of experimental epidemiology. Opie's studies on the spread of tuberculosis in families, Paul's observations *of families with rheumatic disease*, the work on the spread of upper respiratory tract pathogens among small groups of individuals, and detailed bacteriological, clinical and sociological investigations of circumscribed communities throw light on the manner and extent of dissemination of the specific agents and the relation of variations in dissemination, that is, in dosage, to variations in amount and severity of the infection in these communities. They give promise to make more clear the rôle of resistance and whether it consists primarily of inherited non-specific factors on the one hand, or of acquired specific factors.

To broaden the scope of experimental epidemiology the studies must be extended *from* the acute, highly fatal, bacterial diseases of animals to the more chronic ones and to virus infections. This last step is already being taken. Knowledge of many types of infection in many species of hosts will be required for the proper development of epidemiology as a science.

OBITUARY

LOUIS AGRICOLA BAUER (1865–1932)

THE death in Washington on April 12, 1932, of Louis Agricola Bauer, the original director and, since 1930, director emeritus of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, removes from science an internationally recognized authority in the field of his especial interest. Almost solely on account of his enthusiasm and organizing ability, the systematic magnetic survey of the whole earth both on land and on the oceans has been accomplished within the past twenty-five years, by which an empirical basis has been established for theoretical discussions of the origin and behavior of the earth's magnetic field which would otherwise have long remained impossible. While the recognition accorded Dr. Bauer rests largely on this monumental achievement in accumulating a vast amount of observational information, he has also been among the foremost in the discussion of not only terrestrial magnetism but of other related geophysical problems, as is evidenced by the long list of titles with which he is accredited.

Born of German-American parentage on January 26, 1865, in Cincinnati, Ohio, Dr. Bauer received there his early training and obtained from the University of Cincinnati the degrees of civil engineer (1888) and master of science (1894). After a short experience as computer in the Coast and Geodetic Survey under Mendenhall and Schott, his interest in terrestrial magnetism was aroused and he entered the University of Berlin for the purpose of perfecting his theoretical knowledge of that and related subjects. Here he made the acquaintance and came under the influence of the men whose names are inseparably connected with the progress of geophysical science of that period. The subject of his dissertation for the degree of doctor of philosophy obtained in January, 1895, was "Beiträge zur Kenntniss des Wesens der Säkular Variation des Erdmagnetismus."

On his return to America he was appointed docent in mathematical physics at the University of Chicago, and the following year (1896) instructor in geophysics. Then for two years, 1897–1899, he was assistant professor of mathematics and mathematical physics at his alma mater, the University of Cincinnati. In 1899 he was appointed lecturer in terrestrial magnetism at the Johns Hopkins University. During these years his practical interest in terrestrial magnetism was manifested by the work accomplished during the summer months as chief of the Division of Terrestrial Magnetism of the Maryland Geological Survey, during which a detailed survey of the state was made, and when the Division of Terrestrial Magnetism was established at the Coast and Geodetic Survey in 1899 he was made inspector of magnetic work and chief of the division. It was under his direction in this capacity that the five magnetic observatories of the Coast and Geodetic Survey were established and put into permanent operation. At this time also preliminary experiments were made as to methods of securing satisfactory magnetic observations at sea which were to lead to large results a few years later.

Dr. Bauer's theoretical studies had emphasized the hopelessness of attempting to reach a solution of the many fundamental questions involved in the subject of the earth's magnetization until a very much wider distribution of observational results was available. He then conceived the idea of making a magnetic survey of the entire globe, and for the carrying out of this vast project applied for assistance to the newly established Carnegie Institution of Washington. His application was effectively endorsed by the leading geophysicists and magneticians of that time, the more eagerly since the nature of the organization of the institution made it an especially appropriate agency for carrying out an international project of this character. The result was the establishment in 1904 of a new Department of Research in Terrestrial Magnetism, with Dr Bauer as its first director.

During the following 25 years the carrying out of this ambitious project was vigorously prosecuted under the able and zealous leadership of the director. While those land areas were not included in the scope of the operations of the Department of Terrestrial Magnetism where the work was already being done by the governments controlling them, exploratory expeditions were sent to remote regions in Africa, Asia, Australia, South America and the islands of all the seas to make the desired observations. It was early realized that no survey confined to the land areas alone could be satisfactory either for the practical needs of navigation or for the purposes of analysis and discussion. Results of the desired accuracy could not be obtained on vessels of ordinary construction, and so an entirely unique and non-magnetic one, the *Carnegie*, was specially designed and between 1909 and 1929 was sent to all parts of the navigable seas collecting magnetic and oceanographic information not available by any other means yet devised.

While this work was in progress, Dr. Bauer focused attention on the fundamental theory of terrestrial magnetism and published a series of papers dealing with the physical decomposition, analysis and origin of the earth's magnetic field. The last one on "Chief Results of a Preliminary Analysis of the Earth's Magnetic Field for 1922," which appeared in 1923, summarized his latest mathematical analysis as based chiefly on the magnetic data obtained by the Department of Terrestrial Magnetism on land and sea. Fifteen papers, 1892–1923, on the magnetic secular variation dealt with the discussion of the phenomena and the internal and external systems of operating causes; the earth's total magnetic energy was computed by rigorous methods, based for the first time on satisfactory data, for various epochs, 1829–1885, and it was found that there has been a steady diminution in the earth's magnetization—a result confirmed by the analysis for 1922, mentioned above. Dr. Bauer also initiated magnetic and allied observations during eleven solar eclipses, beginning with that of May 28, 1900, he himself making observations during that and three others, to determine possible magnetic effects. Researches dealing with solar activity and terrestrial magnetism were published in twelve leading communications. Others related to correlations between solar activity and atmospheric electricity and the annual variation of atmospheric electricity, and to earth-currents. Space does not permit listing the many other contributions dealing with special problems.

In addition to his extensive contributions to terrestrial magnetism and allied subjects, Dr. Bauer has aided greatly in the development and progress in these fields through the publication of the ***International Quarterly Journal of Terrestrial Magnetism and Atmospheric Electricity.*** He founded this journal in

1896 and was solely responsible for it until 1927, since which time he has collaborated in its continuation.

In recognition of his services to science, Dr. Bauer was the recipient of many honors. The honorary degree of D.Sc. was conferred on him by the University of Cincinnati and by Brown University. He received the Charles Lagrange prize (Physique du Globe) of the Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, the Georg Neumayer Gold Medal, and the insignia of Commander of the Second Class of the Norwegian Order of St. Olaf, and was appointed Halley Lecturer at the University of Oxford in 1913. He was also an honorary member of Sociedad Cientifica Antonio Alzate of Mexico, and of Royal Cornwall Polytechnic Society of England, and corresponding member of Göttingen Academy of Sciences, Portugal Royal Academy of Sciences, Batavia Academy of Sciences, Société de Géographie de Lisbonne, Russian Academy of Sciences, and Institute of Coimbra, Portugal.

Dr. Bauer served as United States delegate to the Brussels (1919) meeting of the International Research Council and to the Rome (1922), Madrid (1924) and Prague (1927) meetings of the International Union of Geodesy and Geophysics. During 1919 to 1927 he was secretary and director of the Central Bureau and during 1927 to 1930 he was president of the Section of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics. Dr. Bauer was a member of the International Meteorological Organization since 1928. He also took from 1917 a prominent part in the National Research Council of the United States and in the American Geophysical Union, being chairman of the latter union from 1922 to 1924.

The breadth of his scientific contacts was indicated also by the large number of scientific societies both at home and abroad of which he was a member. Among these were the American Philosophical Society, American Academy of Arts and Sciences, American Physical Society, American Association for the Advancement of Science, American Geographical Society, Washington Academy of Sciences, Philosophical Society of Washington, Deutsche Meteorologische Gesellschaft and Gesellschaft für Erdkunde zu Berlin.

It is not too much to say that the work of Dr. Bauer has had a large directive influence on the development of terrestrial-magnetic investigation during the past forty years and that the activities of the department which he founded have splendidly realized his vision.

Dr Bauer is survived by his widow, Mrs. Adelia Doolittle Bauer; a daughter, Mrs. Dorothea Weeks, of West Chester, Pennsylvania; a sister, Mrs. Caroline Bauer, of Cincinnati, Ohio, and a brother, Dr. W. C. Bauer, dean of the Engineering School, Northwestern University, Evanston, Illinois.

J. A. F.

WILHELM OSTWALD

With the death of Wilhelm Ostwald there passes the last of the great triumvirate which discovered and developed the theory of solutions and the theory of electrolytic dissociation. The younger generation has a different perspective and adds Nernst's name to the list, very properly.

Three of these, van't Hoff, Arrhenius and Nernst, were really great thinkers, and Ostwald was a great protagonist and an inspiring teacher. So far as the effect on the scientific world is concerned Ostwald has been like Abou Ben Adhem. Ostwald has really outlined his own great value to the world in the book entitled "Great Men."

"When the prospective genius has done his great work and has communicated it to the world, one likes to think that he can go quietly to bed and wake up famous the next morning. There are one or two cases in which that is about what has happened, as in the case of Darwin, whose fundamental book was sold out within a few weeks of its appearance. This is a very rare case, however, and belongs rather in a class by itself, because it was a piece of work which had been going on for years and which was written up because of the external reason that Wallace had reached the same general conclusion. Also, the world was to some extent ready for it.

"In the overwhelming majority of cases, the earth continues to revolve at its normal rate even when the most startling thought has been put forward, and very often the work of getting the new idea accepted is scarcely less than that of originating it. In many cases the man who had the idea is not able to get it accepted and this task falls to the lot of another man who may be less clever, but who speaks a language which makes the world conscious of the treasure which had been offered to it in obscure words."

There are plenty of illustrations in modern chemistry of the truth of these words of Ostwald. The theory of stereochemistry was developed independently by van't Hoff in Holland and by LeBel in France; but it is very much of a question whether either of these men could have got the theory accepted in any reasonable time. Nobody will dispute that the work essential to the adoption of the theory was done by Johannes Wislicenus in Germany. The experiments of Pfeffer on osmotic pressure and of Raoult on the lowering of the freezing-point were very interesting; but nobody knew just what they meant. It was van't Hoff who furnished the theoretical explanation which was lacking and who thereby enabled Raoult and Pfeffer to get the credit which was properly due them. The theory of osmotic pressure was due to van't Hoff, the theory of electrolytic dissociation to Arrhenius, and the modern theory of electromotive force to Nernst; it was Ostwald who fought the battles which resulted in the acceptance of these views. Avogadro was put across by his countryman, Cannizzaro; Gibbs by Roozeboom and by Ostwald; Donnan by Jacques Loeb; and Darwin to a great extent by Huxley.

Ostwald was born in Riga in 1853. In 1872 he entered the University at Dorpat; his first paper was published in 1875 and his doctor thesis in 1878. In 1881 he was appointed professor of chemistry at the Polytechnic in Riga, and here began the publication of the first edition of his "Lehrbuch der allgemeinen Chemie." This was the first book to present physical chemistry as a well-rounded subject, though not under the name that it was to bear later on. This book was one of the reasons why Ostwald was called to Leipzig in 1887 to take over the chair of physical chemistry. In this same year, but before he had moved to Leipzig, Ostwald began the publication of the *Zeitschrift für physikalische Chemie*. The laboratory at Leipzig was at first a ramshackle place; but later a new building was erected. Whether in the old laboratory or the new one Ostwald was the inspiring leader in physical chemistry for the whole world for nearly twenty years. Finally, his mind went stale so far as chemistry was concerned, and he turned to philosophy. It was as a philosopher, not primarily as a chemist, that he came to the World's Fair at St. Louis.

At that time Ostwald was tremendously impressed by the beauty of the autumn leaves and he expressed a desire to paint so many pictures that he would be known as the discoverer of the American landscape. This never happened, nor did Ostwald go back to chemistry after he resigned in 1906. After the philosophy stage had passed Ostwald spent the rest of his life working on the theory of color, and it was a great disappointment to him that the Nobel prize in chemistry was never followed by a Nobel prize in physics for the work on color.

Ostwald's minor activities covered an enormous ground. The volume entitled "The Energetic Imperative" contains his suggestions as to: An international organization of chemists; a universal language; an international coinage; the proper size of a printed page; universal disarmament; the setting of type; the improvement of schools; a new type of university; German script; the development of genius; the status of women, and a new calendar.

Ostwald's gift for leadership showed itself in the way his pupils regarded him. They were literally disciples, and the influence of the Leipzig school was predominant for years in the whole chemical world. Of late years there has been a change. The fashionable thing now is the question of the kinetics of the atom and the molecule. The drift is away from thermodynamics, and one hears regrets that Ostwald did not adopt the goose-step. It is probable, however, that the pendulum has swung too far away from Ostwald and that his scientific work will be rated more highly twenty years hence.

However that may be, Ostwald did a great work and was loved and followed by many people.

WILDER D. BANCROFT

RECENT DEATHS

DR. ROLAND THAXTER, emeritus professor of cryptogamic botany at Harvard University, and honorary curator of the Farlow Herbarium, died on April 22 in his seventy-fourth year.

DR. CARL LEO MEES, physicist, president emeritus of the Rose Polytechnic Institute at Terre Haute, Indiana, died on April 20, at the age of seventy-nine years.

THE death is announced at the age of eighty years of Guillaume Bigourdan, formerly director of the Bureau International de l'Heure, Paris.

J. H. L. VOGT, the geologist and lately professor of geology in the Technical School of Trondhjem, Norway, died on January 3.

PRINCESS VLADIMIR ANDRONIKOFF, head of the Institute for Plant Cultivation at Hohenheim, near Stuttgart, died at Hohenheim on April 1 at the age of fifty-two years.

SCIENTIFIC EVENTS

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS

THE International Congress of Mathematicians will meet at Zurich, from September 4 to 12. The mornings will be devoted to general addresses delivered by invitation, as follows: Monday: R. Fueter, "Idealtheorie und Funktionentheorie"; Tuesday: C. Carathéodory, "Über die analytischen Abbildungen durch Funktionen mehrerer Veränderlicher"; G. Julia, "Essai sur le développement de la théorie des fonctions de variables complexes"; W. Pauli, "Mathematische Methoden der Quantenmechanik"; N. Tschebotaröw, "Die Aufgaben der modernen Galois'schen Theorie"; T. Carleman, "Sur la théorie des équations intégrales linéaires et ses applications"; Wednesday: E. Cartan, "Sur les espaces riemanniens symétriques";

L. Bieberbach, "Operationsbereiche von Funktionen"; M. Morse, "The calculus of variations in the large"; E. Noether, "Hyperkomplexe Systeme in ihren Beziehungen zur kommutativen Algebra und zur Zahlentheorie"; H. Bohr, "Fastperiodische Funktionen einer komplexen Veränderlichen"; Friday: F. Severi, "La théorie générale des fonctions analytiques de plusieurs variables et la géométrie algébrique"; R. Nevanlinna, "Über die Riemannsche Fläche einer analytischen Funktion"; R. Wavre, "L'aspect analytique du problème des figures planétaires"; J. W. Alexander, "Some problems in topology"; F. Riesz, "Sur l'existence de la dérivée des fonctions d'une variable réelle et des fonctions d'intervalle"; Saturday: G. H. Hardy, "Recent work in additive theory of numbers"; G. Valiron, "Le théorème de Borel-Julia dans la théorie des fonctions méromorphes"; W. Sierpinski, "Sur les ensembles de points qu'on sait définir effectivement"; S. Bernstein, "Sur les liaisons entre quantités aléatoires"; K. Menger, "Neuere Methoden und Probleme der Geometrie"; Monday: J. Stenzel, "Anschauung und Denken in der klassischen Theorie der griechischen Mathematik." Sectional meetings will be held in the afternoons, for the presentation of short papers. Those wishing to present such papers should send short abstracts (not more than 400 words) to the Secretary of the Congress, not later than June 15; these abstracts will be printed before the meeting and distributed there. Abstracts received after that date can not appear in the proceedings unless they are delivered before the end of the congress.

Excursions and entertainments have been arranged. All communications concerning the congress should be addressed to the International Congress of Mathematicians, Ecole Polytechnique Fédérale, salle 20 d, Zurich.

ZOOLOGICAL SESSIONS AT THE SUMMER MEETING OF THE ASSOCIATION

SECTION F will hold sessions during the summer meeting of the Association on Tuesday, Wednesday and Thursday, June 21 to 23, at Syracuse, New York. It is planned to emphasize out-of-door zoology by field excursions and informal discussions of ecological and natural history relations. Probably excursions will be made on each of the three days, either for the entire day or shorter half-day trips to representative regions of Central New York. These excursions are expected to be joint sessions of zoologists, ecologists and botanists; leaders will be persons well acquainted with the regions visited. If there are members of the section who do not desire to participate in the out-of-door sessions, provisions may be made for the reading of papers in other fields. Those who desire to present papers should send titles to the secretary promptly. All papers will be limited to 15 minutes each and titles must be accompanied by abstracts of about 250 words giving the substance of the paper. If sufficient papers are presented they will be grouped into appropriate fields. In sending titles the field should be indicative of the group in which the paper should be read, also whether lantern or charts are to be used, and whether microscopes are needed for demonstration. All titles and abstracts must be in the hands of the secretary not later than May 20 if they are to appear in the program.

GEO. T. HARGITT,
Secretary, Section F

DUKE UNIVERSITY,
DURHAM, NORTH CAROLINA

AWARD OF THE OSBORNE MEDAL TO DR. C. H. BAILEY

DR. CLYDE H. BAILEY, professor of agricultural biochemistry in the University of Minnesota and cereal chemist in charge of the section of cereal chemistry in the Division of Agricultural Biochemistry in the Minnesota Agricultural Experiment Station, has been awarded the Thomas Burr Osborne Gold Medal of the American Association of Cereal Chemists "for distinguished contributions in cereal chemistry." The formal presentation of the medal will be made at the annual meeting of the association which will be held from May 23 to 26 at Detroit.

This medal was established in 1926 by the American Association of Cereal Chemists who desired "to honor those scientists who have contributed signally to the advancement of our knowledge in this field of specialization—the award to be made only at such times as were justified by unusually meritorious contributions." The first award was made in 1928 to Thomas Burr Osborne, after whom the medal was named, for his classic studies in the field of plant proteins in general and the proteins of the cereals in particular. Dr. Bailey will be the second recipient of the Osborne medal.

Dr. C. H. Bailey was born in Minneapolis in 1887. He received his B.S. degree from North Dakota State College, the M.S. degree from the University of Minnesota, and the University of Maryland granted him the Ph.D. degree, his thesis being entitled "The Respiration of Shelled Corn." From 1907–1911 he was scientific assistant in the Bureau of Plant Industry, U. S. Department of Agriculture, where again his field of work was cereal chemistry. Since 1911, except for minor interruptions, he has been continuously associated with the Division of Agricultural Biochemistry at the University of Minnesota.

Dr. Bailey was an active member and officer of the American Society of Milling and Baking Technology, the society which was merged with the American Association of Cereal Chemists in 1923, and played a conspicuous rôle in the federated society. When in 1923 it was decided to establish a new scientific journal, *Cereal Chemistry*, as the official publication of the society, Dr. Bailey was selected as editor-in-chief and he served this publication in that capacity during the period 1924 to 1931.

Dr. Bailey is the author of more than a hundred bulletins and papers published in scientific journals. These papers range in content over the entire field of cereal chemistry, including fundamental studies in grain storage, grain grading, milling, the storage of milled products, the evaluation of quality of flours, the process of dough fermentation, the effect of individual constituents in the dough batch, physico-chemical factors in flour and bread manufacture, the baking test, including both the test loaf and its commercial applications, the storage of baked products, rancidity of fats and oils used in baked products, and methods of analysis of cereals and cereal products.

THE AMERICAN PHILOSOPHICAL SOCIETY

At the annual meeting of the American Philosophical Society, held in Philadelphia on April 21, 22 and 23, the following members were elected:

Dr. Edward Goodrich Acheson, chemist, St. Petersburg, Florida, formerly president of the Electro-chemical Society.

Dr. Edward Cooke Armstrong, professor of French, Princeton University.

M. Gilbert Chinard, Department of French Literature, the Johns Hopkins University.

Dr. Ralph Erskine Cleland, professor of biology, Goucher College.

Dr. Arthur J. Dempster, professor of physics, University of Chicago.

Dr. Arnold Dresden, professor of mathematics, Swarthmore College.

Dr. Herbert Fox, professor of comparative pathology, University of Pennsylvania.

Dr. Edwin Francis Gay, professor of economic history, Harvard University.

Dr. George Lincoln Hendrickson, professor of Greek and Latin literature, Yale University.

Dr. Edwin Walter Kemmerer, professor of international finance, Princeton University.

Dr. Thomas William Lamont, New York.

Dr. Arthur Oncken Lovejoy, professor of philosophy, the Johns Hopkins University.

Dr. Elmer Drew Merrill, director of the New York Botanical Garden.

Dr. John Raymond Murlin, professor of physiology and director of department of vital economics, University of Rochester Medical School.

Dr. Charles P. Olivier, professor of astronomy and director of the Flower Observatory, University of Pennsylvania.

Dr. Ernest Minor Patterson, professor of economics, Wharton School of Finance and Commerce, University of Pennsylvania.

Dr. Henry A. Sanders, professor of Latin, University of Michigan.

Dr. Jacob Richard Schramm, editor-in-chief of *Biological Abstracts*.

Dr. Charles P. Smyth, associate professor of chemistry, Princeton University.

Dr. Edward Lee Thorndike, professor of psychology and director of the division of psychology, Institute of Educational Research, Teachers College, Columbia University.

Dr. Richard Chace Tolman, professor of mathematical physics, California Institute of Technology.

Dr. Henry Van Peters Wilson, Kenan professor of zoology, University of North Carolina.

Dr. Sewall Wright, professor of zoology, University of Chicago.

Foreign members elected were:

Ramon y Cajal, Madrid.

Dr. William H. Collins, Canada.

Professor David Hilbert, Göttingen.

M. Emmannuel de Margerie, Paris.

Dr. Ivan Pavlov, Leningrad.

Mr. Roland S. Morris, formerly United States Ambassador to Japan and member of the Philadelphia bar, was elected president. He succeeds Professor Henry Norris Russell, of Princeton University. Dr. James H. Breasted, Dr. Elihu Thomson and Dr. Edwin G. Conklin are the vice-presidents; Dr. Arthur W. Goodspeed and Dr. John A. Miller, secretaries; Dr. Albert P. Brubaker, curator, and Dr. Eli Kirk Price, treasurer. Dr. Cyrus Adler, Dr. Henry H. Donaldson, Dr. Herbert S. Jennings, Mr. William L. Phelps and Dr. Heber D. Curtis were elected members of the council.

SCIENTIFIC NOTES AND NEWS

Dr. Phoebus A. Levene, member of the Rockefeller Institute for Medical Research, has been elected a member of the Deutsche Akademie der Naturforscher zu Halle, on the occasion of the celebration of the centenary of the death of Wolfgang von Goethe.

Dr. J. C. Th. Uphof, head of the department of biology and professor of botany at Rollins College, was recently elected a corresponding member of the Bulgarian Botanical Society and of the Royal Netherlands Agricultural Society.

Dr. Dukinfield H. Scott, the British paleobotanist, has been elected a member of the Prussian Academy of Sciences.

M. C. CANTACUZENE, of Bucharest, and M. Emile Guyénot, of Geneva, have been elected corresponding members of the Paris Academy of Sciences in the section of anatomy and zoology.

PROFESSOR G. ELLIOT SMITH, professor of anatomy in University College, London, has been given the honorary degree of M.D. by the Egyptian University, Cairo, on the occasion of its first convocation, held on February 27. Professor Elliot Smith was at one time professor of anatomy in the Government Medical School, Cairo.

DR. WILLIAM LAWRENCE BRAGG, professor of physics at the Victoria University of Manchester, has been elected a member of the Athenæum, London, under a provision which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts or for public service.

THE presentation of the Faraday Medal of the British Institution of Electrical Engineers was made to Sir Oliver Lodge at a meeting of the institution on April 23. On this occasion Sir W. E. Sumpner delivered the twenty-third Kelvin Lecture on "The Work of Oliver Heaviside."

THE Messel Medal of the British Society of Chemical Industry has been awarded to Sir William Pope, professor of chemistry and director of the chemical laboratories at the University of Cambridge.

THE British Dyers' Company Gold Research Medal for the period 1930–31 has been awarded to Professor F. M. Rowe, head of the department of color chemistry and dyeing at Leeds University, for a series of three papers on the chemical and physical effects of kier boiling on insoluble azo colors on the fiber. This is the third occasion on which Dr. Rowe has received this medal.

DR. ALFRED COX, the medical secretary of the British Medical Association, will retire this year, after having held his office for twenty years. To mark their appreciation of his services, the members have raised a testimonial fund, out of which the association has been provided with an oil painting of Dr. Cox, by Sir Arthur Cope, R.A. Dr. Cox will receive a book containing the names of the subscribers, and a check. The portrait is now at the Royal Academy.

DR. ROBERT G. AITKEN, director of the Lick Observatory of the University of California at Mount Hamilton, with Mrs. Aitken, is now on his way to England where he will receive next month the gold medal of the Royal Astronomical Society.

DR. EARLE R. HEDRICK, professor of mathematics and chairman of the department of mathematics at the University of California at Los Angeles, has been named by the French government as "Officier d'Academie" "for services rendered to the cause of culture and science."

DR. ROBERT TAFT, professor of chemistry at the University of Kansas, was elected president of the Kansas Academy of Science at its recent meeting at McPherson College.

M. LOUIS MANGIN, who recently retired as director of the Museum of Natural History, Paris, and as professor of cryptogamic botany, has been elected honorary director.

DR. DENNETT L. RICHARDSON has been elected superintendent of health at Providence, Rhode Island, to succeed Dr. Charles V. Chapin, who recently retired after forty-eight years' service. Dr. Richardson is superintendent of the Providence City Hospital, the name of which has been changed to the Charles V. Chapin Hospital.

AT a meeting of the Connecticut State Dental Association, March 30, Dr. Milton C. Winternitz, dean of the Yale University School of Medicine, New Haven, was presented with the Newell Sills Jenkins Memorial Medal for meritorious service to the dental profession. The medal is awarded each year to the person who has made a notable contribution to dentistry, science or humanity. It has been awarded annually since 1922.

DR. E. L. NIXON, professor of plant pathology at the Pennsylvania State College, has been given the award of the Philadelphia Society for Promoting Agriculture "in recognition of his outstanding achievement in making practical, and within reach of all, a method whereby the production per acre of potatoes has been so remarkably increased, thereby conferring upon his fellow citizens of this and other states, who may be interested in this industry, a benefit of great and lasting value."

DR. W. REID BLAIR, director of the New York Zoological Park, was the guest of honor on April 15 at a dinner given by the employees of the park in celebration of his thirtieth anniversary as an official at the park. Dr. Claude Leister, curator of educational activities, presided. Mr. Cyril J. Newman, representing the employees, presented to Dr. Blair a gold watch engraved with his record of service in the park.

DR. THOMAS S. ROBERTS, professor of ornithology and director of the Museum of Natural History at the University of Minnesota, recently completed his work on "The Birds of Minnesota." Publication of the work has been made possible through the establishment of the Thomas S. Roberts fund by citizens of Minneapolis. Proceeds from the sale of the book will become a permanent trust fund for the Museum of Natural History, of which Dr. Roberts has been head for the past seventeen years.

Dr. Peter Hervy Buck, of Honolulu, has been appointed Bishop Museum visiting professor of anthropology. He will give instruction next year at Yale University and direct research in the problems of the Pacific area under the terms of the agreement by which Yale and the Bishop Museum of Honolulu are affiliated.

Professor C. K. Ingold, professor of organic chemistry at the University of London, is visiting Stanford University for the spring quarter. He is giving a course of lectures on "Organic Reactions," which are being considered from an electrochemical viewpoint based on the electronic theory of valency.

Professor George F. Bateman has been appointed acting dean of engineering at Cooper Union, New York City. He succeeds the late Dean Francis M. Hartmann, who died recently after thirty years of service on the engineering faculty. Assistant Professor Norman L. Towle has been promoted to a full professorship in charge of the department of electrical engineering.

Promotions to professorships in the University of California include S. B. Freeborn, in entomology; Tracy I. Storer, in zoology; H. S. Smith, in entomology; R. B. Brode, in physics; and in the Medical School, San Francisco, F. S. Smyth and I. M. Thompson, in pediatrics, and R. O. Moody, in anatomy.

Dean Hugh P. Baker, of the School of Forestry, Syracuse University, has been appointed a member of a committee organized by the Association for the Protection of the Adirondacks in connection with promoting a public protest against the recreational amendment to the Constitution of the State of New York which provides for cutting timber on the forest preserve lands to make clearings for entertainment structures, which will come up for ratification by the people next fall.

Dr. Oliver Justin Lee, associate professor of astronomy at Northwestern University, will make observations next summer at Fryeburg, Maine, with the aid of airplanes and captive balloons to find out the changes in the temperature and pressure in the air at a series of specific altitudes during the total eclipse of the sun on August 31. Aerological instruments will be placed in the airplanes and captive balloons to record the changes. Three or four balloons will be used in the first 1,000 feet of altitude. Commercial airplanes will be held at 3,000, 8,000 and 15,000 feet, and Professor Lee is negotiating with the United States Navy for a special navy plane to operate at 25,000 or 30,000 feet. The airplanes will arrive at their specified levels at least half an hour before the eclipse and will fly at easy cruising speed until the eclipse, which will last ninety-nine seconds, has passed. Dr. C. F. Marvin, chief of the United States Weather Bureau, who will provide the aerological instruments and assist in decoding the records, and Rear Admiral Walter B. Gherardi, hydrographer of the United States Navy, will probably accompany Professor Lee to Fryeburg. Captain Barnett Harris, of the United States Army Signal Service, photographer of eclipses, will also be with Professor Lee. He will have with him a battery of four motion-picture cameras equipped with special lenses and will if possible make a complete motion picture of the eclipse.

Dr. Frank Aydelotte, president of Swarthmore College, who is visiting Mexico City, is leaving for Germany, where he will study biological research laboratories. Swarthmore College has received an anonymous gift of $900,000 for the erection of a biological laboratory in memory of Dr. Edward Martin, formerly head of the U. S. Health Department. The building will cost $200,000 and the balance will be used for equipment and endowment.

Dr. Wilhelm Blaschke, professor of mathematics at Hamburg, is making a lecture tour during 1932. He will lecture at the University of Chicago and other American universities and at the Universities of Annamalai and Calcutta, India, and the Universities of Tokyo and Sendai, Japan.

Dr. Robert A. Millikan, of the California Institute of Technology, gives the first James Arthur Foundation Lecture at New York University on April 29. His subject is "The Historical Aspects of Time Measurements and their Significance in the Development of Science."

The Edgar F. Smith Memorial Lecture will be delivered in the Harrison Laboratory of Chemistry of the University of Pennsylvania on Friday, May 20, at 4 o'clock. The lecturer will be Professor Louis Kahlenberg, of the University of Wisconsin, who will speak on "The Relationship between Electrical Potentials and Chemical Activity."

Dr. A. E. Kennelly, professor emeritus of electrical engineering at Harvard University, gave the second Joseph Henry Lecture on "The Work of Joseph Henry in Relation to Applied Science and Engineering" before the Philosophical Society of Washington on April 23.

Mr. Aldous Huxley will deliver the Huxley Memorial Lecture at the Imperial College of Science and Technology, London, on May 4. The subject of the lecture will be "Huxley as a Literary Man."

THE Psi chapter of Sigma Pi Sigma, honorary physics fraternity, was installed at Purdue University on April 12. Dr. Marsh W. White, of the Pennsylvania State College, executive secretary, and Dr. M. N. States, of the Central Scientific Company, national president of the fraternity, were the installing officers. After the twenty-seven charter members of the chapter were initiated the new chapter conferred honorary membership upon Dr. Cornelius Lanczos, professor of mathematical physics at the University of Frankfort, Germany. Dr. Lanczos is visiting professor at Purdue University. After the installation dinner an open meeting of the chapter was addressed by Dr. Lanczos, who spoke on "Maxwell, and his Influence on Modern Magnetic Theory." The installation of the Purdue chapter brings the roll of chapters of Sigma Pi Sigma to twenty-three.

DR. CARL E. SEASHORE, dean of the Graduate College, State University of Iowa, gave the initiation address at the annual initiation of the Iowa Chapter of Sigma Xi on April 27, speaking on "The Scholar as a Person." The initiation included 102 new members. Professor E. I. Fulmer, of Iowa State College, also participated in the initiation, speaking on "The Aims and Emblems of Sigma Xi."

THE Iowa Academy of Science will hold its forty-sixth annual meeting at Iowa State Teachers College, Cedar Falls, on April 29 and 30. Dr. James H. Lees, of the Iowa Geological Survey, will give the presidential address on "Our Underground Geology." The academy lecture will be presented by Dr. L. L. Thurstone, of the department of psychology of the University of Chicago, on "The Measurement of Social Attitudes." Section meetings for the presentation of papers in special fields of science have been provided. The Junior Academy of Science of Iowa holds its first annual convention with the parent organization this year.

THE American Association of Museums meets at Cambridge this year on May 12, 13 and 14. Eight sections of the association are arranging twenty-two special programs covering almost every branch of museum interest. There will be a conspicuous absence of formal business in order to give time in three days for these conferences, besides three general sessions, discussions, entertainment and a banquet at the Fogg Art Museum. Several distinguished guest-speakers, including President Lowell, of Harvard, will be present. Headquarters will be the Commander Hotel. Reservations should be made at once. The special rate is $2.50 a day per person. Applications for double rooms with bath are urged to conserve accommodations. Reduced railroad fares have been granted on the certificate plan.

DISCUSSION

THE FIELD NATURALIST IN THE FINAL INTERPRETATIONS OF LIFE

NOTHING seems more obvious to me than the fact that the livingness, the behaviors of life are externalities which must eternally be interpreted in their own terms and magnitudes. Advance inward a fraction beneath the surface, and all the familiar externalities of life vanish. One encounters, then, infinite levels of action and interaction from the surface to the electronic depths. As we recede from the surface view of life, we meet ever-expanding planes of complexity until an organism in terms of its electrons or free energies or anything else from the ultra-physical point of view must mean nothing but a vast realm and play of restless force approaching immateriality, call it what we will. Chemistry represents but one small level of analysis, physiology another, morphology another, electro-magnetic behaviors another, *ad infinitum*, until the molecules, atoms and spinning electrons themselves are reached, and the personal warmth and touch of life is no more.

It is legitimate to ask: Why stop at any level, the most superficial, in this weird organic complex with the external behaviors of life at one end and vast electronic depths at the other? Cellular studies seem simple enough, but what of their aggregates? The bricks of the house, too, are simple units, but a study of the individuality of bricks will not help us to comprehend the art, the style of the architecture of the completed structure. One brick tells nothing, nor two nor ten nor a hundred. Nothing is seen nor felt until those commonplace bricks are built into their final orderly arrangements, and the externality of a particular form is created. Life in a sense is as fugacious as art; life is the art of organic expression, and a John Burroughs or an Alexander Wilson or a Ruskin alone will interpret the finalities of it all for us.

Life, somehow, is externally a translation upward of forces and behaviors from one level to another. The final theme of the organic complex is living expression, but there is a new, a subordinate theme for every subordinate level. The bird in the totality of its morphology and physiology builds a particular nest and sings a specific song, and it behaves thus in virtue of an infinite number of component levels of internal interactions. Song is not to be sought in one organ or in two, constituting any one of its dissected and exposed physiological or morphological levels, nor in the complexities of any chemical level involving hydrogen-ion relations, blood plasmas or corpuscular affinities. Let us finally decide to study life in the properties of proteins, sugars, starches. We find no hint of the manifestations of life here. We will study the molecule, the atom, the electronic whirls and modes even more intensively. All well and good, but we can not expect to find any of the externalities of life in these remote depths of a bird's chemistry. There appears to be nothing to indicate the properties of atomic iron in the electronic energies of iron. Surely the properties of the iron atom do not allow one to predict the properties of any organic molecule into which iron enters as a constituent. At every point new property-levels are built up, one within or upon the other until the resultant of all is the subtle mood of living-expression, which we would all understand if we could.

To my own mind there is no hope of tracing life which is a summation-property, to any internal subordinate level beneath the bones and integuments, so to speak. I would as soon declare that the facies of life existed at one level as another, and hold that the free energy of the electrons should contain its embryo as truly as the morphologically immature embryonic configuration.

With these features in mind, I find great justification for the broader view-points of the genuine field-naturalist. Yet some look askance at him in these days of intensive specialization. The true naturalist is content to see the final resultant of all these interior interacting levels of structure and function, and in truth the final relevancies of life must be sought alone in its external features of form and expression. While the old-time naturalist has become scarce in our midst, it is simply because the newer psychology of organisms has thought to find the key to life in the internal relations of its mechanism. Henry David Thoreau, beholding the sunset with soul attuned to the beauty of it all, is as true a scientist as Leeuwenhoek bringing to light the sperm cells of life. One works on a more external plane than the other—that is all. The man studying chromosomes is content with the details of chromosomes, but if he seeks finality in their relations, he becomes for the moment a naturalist engaged with the external properties of life.

For that reason, a Thoreau studying the relation of his moods to the whip-poor-will's calling, term him poet-naturalist if you will, is a genuine out-and-out naturalist, nevertheless. The electronist, the chemist, the biophysicist, the physiologist, the morphologist, on and on are but subepidermal naturalists in their restricted fields. The true naturalist, the man who must always stand upon their isolated summations, ever transcending all the complexities of their intracellular finds, must be the old-time field-naturalist. Let him now touch his own subtle moods with the poetry and the philosophy of it all; let him stand as a complete entity before the wonders of the gods and he becomes, still more, the calm poet-naturalist in our midst, with sublimities of thought and feeling projected infinitely beyond the levels of his colleagues lost within the organizing integuments which somehow made all this possible as the final vision of life. At last, perchance, moments of mystical experience may lift the soul above mundane relations, and he will, like Wordsworth, feel close to some immanence in the universe.

> When the light of sense
> Goes out, but with a flash that has revealed
> The invisible world.

It is then that we have seen and felt infinitely beyond the confines of our own finite personalities, with a rare vision and mood that glimpses even the gods themselves. It is then that the scientist feels the reality and greatness of an infinite externality of being, it would seem, and the innate religious consciousness of man has asserted itself as the final logical outlook of life.

H. A. ALLARD
U. S. DEPT. OF AGRICULTURE

SPONTANEOUS COMBUSTION IN THE MARSHES OF SOUTHERN LOUISIANA

THE following is abstracted from my notes on observations of marsh fires of apparent spontaneous origin. My complete notes on the subject appeared in *Ecology*, Vol. XII, No. 2, April, 1931.

On August 4, 1924, shortly before noon, while hiking in a dried marsh two miles east of Mandeville, Louisiana, with a party of boy scouts, we observed the start of a fire which apparently ignited spontaneously. The muck-like soil of the marsh, as rich as 90 per cent. in combustible matter near the surface, varies from a few inches to several feet in depth. We were in the midst of an unprecedented drouth, and the water level, which normally would stand a few inches above the grass roots, was several feet below the surface, all but a few deep lagoons and the bottom of alligator holes being without water. The temperature was over 100° F. in the shade, and in the sun the heat was so intense that it was impossible for the boys to walk barefooted in the sand. A strong southwest wind, estimated at 20 to 25 miles per hour was blowing across the lake.

One of the boys called my attention to a column of smoke about a foot in diameter, rising from the marsh about one eighth of a mile in from the lake. We immediately ran to the fire to check it if possible and determine its origin, but, because of the nature of the combustible matter and the strength of the wind, it was already beyond control. As the partly dried marsh vegetation was not anywhere over 3 feet in height, no human could have been there without being seen. Although not a single fire had been observed in the marsh or near-by pine woods prior to this date, and the lake shore was uninhabited for about 15 miles to the eastward, we observed quite a number of large fires scattered over that area during that afternoon, which I could not attribute to accident or design by human agency. They were not along the lake shore, highways or byways where one on foot, horseback or automobile would have been apt to set them, nor along the shores of bayous where one traveling by boat would be likely to set them. A single person could not have covered the territory, even upon horseback, in a day, and the nature and depth of the muck, with the occasional bayous, would make travel by horseback impractical if not impossible.

Looking at the physical facts in the case, we find existing at the time some of the same conditions which bring about the spontaneous heating and ignition of agricultural and industrial products, combined with such weather conditions as always accompany the most disastrous forest and grass fires. That summer, similar rather sudden epidemics of fires occurred in muck soils in drained lands near my home in New Orleans. In one case I noticed what appeared to be a very small fire breaking out on the side of a stump in an empty lot, and I secured a bucket of water to extinguish it. It really took several buckets, for the fire had burned a large hole in the muck soil, and the condition of the under side of the cypress stump showed that it had been burning for some time in a partly smothered condition, and was only breaking through to the surface when observed. During a similar interval, a fire started with a match or cigarette would have set all the dried weeds and grass in the lot in flame and would not have burned the ground so deeply under the stump before spreading. Of course, because of the almost continued presence of people on the outskirts of New Orleans, I would have hesitated to attribute any of these fires to spontaneous ignition, had I not been an eye-witness to the fire in the marsh near Mandeville on August 4.

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RHYTHMIC PHENOMENA IN GELS

IN a paper which was presented at the Buffalo meeting of the American Chemical Society (April, 1919), but which was not submitted for publication, the writer demonstrated the musical vibration and rhythmic splitting of silicic acid gels. The former of these two phenomena was also demonstrated at the same meeting[1]; the second phenomenon was recently described in great detail.[2] A third phenomenon, which the writer also reported and which does not appear to have been observed since, is the variation of pitch with time, which precedes the fracture of the gel. After silicic acid gel sets, it produces a low musical note which increases in pitch, with time, at a varying rate. Sometimes the change is too rapid to be followed and again it may be so slow that the change from the lowest to the highest pitch can be followed through all the intervening tones for a period of several days. Sometimes the pitch at the time of fracture is too high to be heard and again the fracture may occur at some lower note.

Another phenomenon which the writer observed was the production of overtones by gels contained in tubes having an irregular shape.

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BEHAVIORISM IN SCIENCE

PSYCHOLOGY has borrowed much and learned more from the older sciences. It has thus come by method, instrument, procedure and attitude toward the problems of investigating that aspect of nature known as mental life. Mental life is now regarded as part and parcel of nature in general, not as something added or superposed on nature. This has been a great advance, but one which is yet not fully realized by all thinkers.

There has been much ado both within and without psychology over the term "behaviorism." Those to whom the term applies are either extolled as epoch makers in psychology or condemned as destroyers of mental life. Judging from the amount of discussion for and against behaviorism, one would suppose that it was something new on the intellectual and scientific horizon. Perhaps it is not. Behaviorism is an age-old concept or method. Although not specifically called by that name it has been taken for granted in all sorts of inquiries, even in the biological sciences, to which group psychology belongs. Why, then, has its advent caused such a furor in psychology or, better, why has its advent in psychology caused such a furor?

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[1] H. N. Holmes, W. E. Kaufmann and H. O. Nicholas, *Jour. Am. Chem. Soc.*, 41, 1329, 1919.

[2] E. C. H. Davies, *Jour. Phys. Chem.*, 35, 3618, 1931.

We are frequently reminded that psychology is a young science—not far removed from the parent philosophy and it must be remarked that this attitude with respect to behaviorism, both on the part of "believers" and "non-believers," is eloquent testimony as to its immaturity. This is not saying that behaviorism is this or that but merely that some psychologists and others are as yet in a state of mind which might be labeled semi-scientific and semi-philosophical with respect to the investigation of mental life. Scientifically, their thinking is belated.

If we consider the history of scientific effort and investigation since the beginning of man's curiosity about the world and himself we find that he has been observing behavior and recording its uniformities and irregularities. To make it intelligible he has invented theories and constructed hypotheses and scientific laws which are nothing more or less than statements of uniformities in behavior. The chemist looking at a precipitate in a test-tube, Newton regarding the falling apple, if the story is true, were observing behavior. So, too, each in his own sphere—the geologist, the physiologist and the biologist. No one says uncomplimentary things about these scientists because they study the behavior of certain aspects of nature and are thereby behaviorists in so far. Why, then, should the psychologist incur the anathemas of various and sundry, including some of his own relations?

Behaviorism may be right or it may be wrong, but it is no more so in psychology than in any other science. The confusion arises because oftentimes the psychologist and those interested in psychology try to be or try to do two things at the same time, with the result that neither is done well. They confuse fact and purpose, finite and infinite, uniformity and teleology, science and philosophy. Most scientists find enough to do at home and are content to observe, record and explain behavior as found in his own field. Not so with a considerable number of psychologists. As to the ultimate behind, beyond or beneath, they should not presume to discuss as physicists, chemists or psychologists. It is not their field. Some attempt to be philosophers as well as psychologists. Except in the case of a monumental genius the two attitudes produce nothing but confusion. The psychologists should be scientists first, last and always, leaving the ultimates to the philosophers. In the realm of intellect, it is their function to provide perspective, to evaluate findings, to correlate the results of the various sciences into a world-view as also to furnish an interpretation as to what is the meaning of the behavior of that which we investigate and observe. (If ever such a service was needed it is needed now, for the world is suffering from scientific indigestion.) This confusion of aims on the part of the psychologists is the result of an imperfect separation from philosophy really amounting to an immaturity of outlook and attitude.

The psychologist is only a scientist when he is thoroughly objective. Mental facts are observable only as the behavior of the organism. When, however, any one asserts that there is nothing but the response of the organism he is as mistaken as other pseudo-philosopher. That is how the behavioristic school has shown its youth and immaturity as much as any other school of psychology. A denial of consciousness is just as much beside the mark as its affirmation, and the behaviorist is quite as absurd as those whom he condemns. The psychologist as a scientist should do neither. He should be content to take human nature for granted and investigate his special field, just as other scientists take their special fields for granted. The finals, the interpretations, the unifyings, the harmonizing, the ultimates of all sorts and kinds come within the ken of the philosopher. If that division of labor is carried out then a self-imposed burden is removed from the psychologist and he will find time to be a scientist.

Behaviorism, then, is a scientific attitude common to all scientific endeavor, and if the psychologist takes that attitude as a scientist then he ought not to incur an odium from those whose intellect is alive. As long, however, as he mixed the factual with the purposive, confusion of thought is bound to occur both in his own mind and in the minds of others. Let him, content to be a humble scientist, let others soar to philosophic heights. As soon as psychology becomes purely objective this dualism of outlook will disappear. At present it has not reached that stage. Psychologists, by being scientists will be better psychologists, and by being better psychologists will be better scientists. Their philosophy may suffer, but that may be no great hardship.

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QUOTATIONS

INTERNATIONAL COOPERATION

At a Conference of Institutions for the Scientific Study of International Relations, held in Copenhagen in June, 1931, progress was made in the fundamental study of international relations, and the possibility of a systematic study of actual problems on international relations, either on the lines of the Institute of Pacific Relations or by entrusting particular researches to individual institutions, was discussed. A study of the international implications in the relations between government authority and private economic activities of individuals and groups, with special reference to the new forms of public management, control, and supervision, national or international, direct or indirect, which have grown up since the war, and the motives and policies underlying them, is contemplated at the next conference. The possibility of a fundamental scientific study of the problem of disarmament was also suggested.

In industry, where an international outlook has become much more prevalent and the importance of scientific leadership is increasingly recognized, the possibilities visualised by General Smuts have found even more concrete expression. Sir Harry McGowan has already thrown out the suggestion of an International Council for Chemical Industry which would plan chemical industry as a world unit in regard to production, research and development. The World Social Economic Conference held at Amsterdam last August led to definite proposals for a five-year world plan which was to be based on world solidarity, the modification of national economic policy in accordance with its effect on world economy, and the pooling of losses due to the war. The plan involves a general moratorium on all war debts and reparation payments, a series of international loans and agreements in regard to markets and production, and the establishment of a World Research Council or Planning Board to stimulate thought and action in the planning and rational organization of the social and economic life of the world.

Were not scientific workers, as Ruskin remarked, "still eager to add to our knowledge, rather than to use it," the new opportunities confronting them of making a vital contribution to the solution of our present difficulties would have been seized with avidity. Not only industry but also whole sections of the nation are disposed to accept the leadership of science and to adopt a well-thought-out and comprehensive scheme of national and international reconstruction based upon an authoritative and scientific analysis of the whole situation. No such scheme can, however, be produced until scientific workers are sufficiently concerned with the economic and social consequences of their work to cooperate with industrialists and others who are imbued with the scientific outlook and capable of assessing the value of scientific method and knowledge. In such cooperation there should be adequate safeguard against the neglect or abuse of human values, which Bertrand Russell fears and depicts so vividly in his sketch of scientific society and scientific government.

There are all the signs that the age of individualism and competition is passing and will be succeeded by an age of cooperation and planning on a world scale. The danger is still acute that old prejudices may delay the transition and precipitate a conflict from which the recovery of civilization will be impossible. The existence of political prejudices in government circles should not lead us to overlook the facts that nowhere does prejudice and individualism linger more persistently than among the very scientific workers whose discoveries have made world cooperation and the renunciation of war at once inevitable and urgent. Even the difficulties and limitations on the intellectual classes and the intellectual progress of mankind directly imposed by the burden of armaments under present conditions have not sufficed to rouse general interest among scientific workers, or to induce them to make their fitting contribution in the analysis of the problem. Statesmen, indeed, need to take account of our prejudices as well as of the facts of life. Reason alone may be an incomplete guide for the control of human affairs and lead us into a tyranny which becomes intolerable to human nature because of its disregard for human values. Knowledge and leadership must be indissolubly linked if disaster is to be avoided, and to no class of the community is there a stronger challenge in the present emergency than that addressed to scientific workers to declare with a united and unequivocal voice the potentialities of science in the evolution of a better world order and the lines upon which a systematic policy can be evolved.—*Nature*.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

INFLUENCE OF METHOD OF SHAKING ON AMOUNT OF PHOSPHATE DISSOLVED FROM SOIL BY WATER

DISCORDANT results were obtained during the course of experiments designed to determine the optimum time for shaking a soil-water suspension in order to dissolve phosphate. Much more phosphate was dissolved from sandy soils when vigorously shaken than when gently agitated. There was only a small difference in the amounts extracted from clay soils whichever method of shaking was used. This note is written merely to direct attention to the facts observed, not as indicating intention to make a study of the subject.

The conditions were about as follows: Two grams of air-dry powdered soil with 200 cc of distilled water were placed in 500 cc wide-mouth bottles closed by rubber stoppers. After shaking the mixture for a definite time, it was filtered on ashless filter-paper on a Buchner funnel by the aid of suction. The first of the filtrate, which was turbid, was returned to the filter until it came through clear. In the clear solution, PO_4 was determined by the molybdenum blue method.

Two quite different shaking machines were employed. One had a reciprocal motion with a stroke of about two inches at the rate of 120 per minute. In this the bottles lay on their sides so placed that the motion was lengthwise of the bottles. Since the bottles were less than half full, their contents were rather violently agitated. The longer the time of shaking the greater was the amount of PO_4 dissolved from sandy soils. With clay soils time did not make so much difference.

In the other shaking machine, the bottles were placed with their longer axes perpendicular to the axis of the rotating holder in such manner that they were turned end over end at the rate of four revolutions per minute, which scarcely did more than keep the contents of the bottles mixed by very gentle agitation. After it was found that the method of shaking made much difference in the amount of phosphate dissolved, the position of the bottles in the end-over-end shaker was changed so that their long axes were parallel to the axis of the machine. In this way, the bottles were turned over by a sort of rolling motion which kept the contents in motion without violent agitation. The rotation was so gentle that an ordinary filter-paper placed in the soil suspension was not torn after two hours of agitation. In the reciprocal shaker, the filter-paper was disintegrated to pulp in a few minutes.

Results recorded in the appended table seem to indicate that about one hour's agitation in the end-over-end shaker is long enough for clay soils. With even this gentle motion, the PO_4 dissolved from soil 30, a fine sandy loam, increased with the length of time shaken, so that the length of time for shaking a sandy soil has been arbitrarily set at one hour, with the knowledge that slight changes in the conditions may cause considerable difference in the results. It appears probable that discordant results in the analysis of soils for various constituents have frequently been caused by differences in the method of mixing or agitating the suspension before filtering off the solution.

In this connection, it is of interest to note that workers in physical analysis of soils observe that the amount of colloidal matter extracted from some soils is increased by longer time of agitation of the suspension before making the separation.

EFFECT OF METHOD OF SHAKING ON PO_4 EXTRACTED FROM SOILS BY SHAKING WITH WATER

Kind of shaker	Time shaken	Soil numbers					
		Silty clays, No.'s			Sandy soils, No.'s		
		1c	38	65	30	53	68
		p.p.m. PO_4 in air-dry soils					
Reciprocal	1 hour	50	63	316	234	74	37
"	2 "				274		
End over end		49	49	316	100	37	30
Rotary	1 min.	21					
"	1 hour	42					
"	2 "	45					
"	½ "	40			58		
"	1 "	44			68		
"	2 "	43			82		

Shaken by hand once every five minutes for one hour, then filtered:

Very gentle shaking 57

Violent shaking 65

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A METHOD OF ARTIFICIALLY FEEDING THE SUGAR-BEET LEAFHOPPER

CARTER[1, 2] devised an apparatus for the purpose of artificially feeding the sugar-beet leafhopper, *Eutettix tenellus* (Baker). He pointed out that this device is also suitable for studies on the properties of the curly-top virus and for nutritional studies with sucking insects.

For certain biochemical investigations on the curly-top problem, Carter's apparatus was found to be unsuitable. It became necessary therefore to devise a method whereby the sugar-beet leafhopper and other closely related species could be fed artificially on very small amounts of solutions of known composition.

Pieces of glass tubing 1.5 cm in diameter and 2 cm in length served as the cage. One end of the cage was covered with cheesecloth, which was held securely in place by a rubber band. A section of paraffin ribbon, cut 60 microns in thickness with a microtome, was stuck to the other end of the cage after the leafhopper had been placed inside. The assembled cage is shown in Fig. 1. The animal mesentery membranes or the baudruche capping skins used by Carter were

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[1] *Jour. Agr. Res.*, 34: 449–451, 1927.

[2] *Phytopath.*, 18: 246–247, 1928.

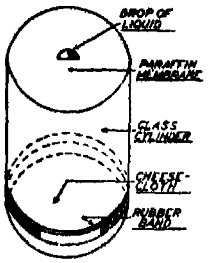

FIG. 1. Feeding device for the sugar-beet leafhopper. The insect caged in the glass ring punctures the paraffin membrane and feeds on the drop of solution.

found to be very unsatisfactory for pH determinations. When this type of membrane is wetted by liquids, adsorption of ions takes place and a serious error is introduced into the determinations. The paraffin membranes being chemically inert and easy to prepare and handle were found to be well adapted for the studies carried out.

The leafhoppers have no difficulty in getting a foothold on the paraffin membrane. There was usually a delay in finding the drop of liquid placed on the membrane if no assistance was given the leafhopper. To expedite matters, the practice was followed of waiting until the leafhopper began to puncture the membrane and then placing a drop of the liquid directly over the leafhopper. In this way it was possible to induce hungry leafhoppers to feed almost at will. The drop placed on the membrane can be protected from air and evaporation by an air-tight compartment made of the same size glass tubing. The drop can even be subjected to different gases by using such a covering chamber into which side tubes are sealed.

To study the pH of saliva injected into the drop by a leafhopper, one was allowed to feed on a drop (.01 cc) of slightly buffered 5 per cent. sugar solution. The pH determinations made on a large number of leafhoppers show that the material injected into the drop of liquid by the leafhopper is very alkaline. This was confirmed by allowing leafhoppers to feed on a drop of brom thymol blue. The drop of brom thymol blue (made acid) would turn from a lemon yellow to a deep green and in some instances to a blue color within three minutes after the leafhopper had started to feed.

In the early part of the work it was observed that some leafhoppers, while feeding, ejected a substance which very quickly coagulated around their mouth parts. To study this process another cage was designed so that it could be mounted on a slide and placed under the microscope, Fig. 2. Narrow strips were cut from the end of a micro-slide approximately 1.5 mm in thickness. Small compartments were made by sealing two such pieces parallel with each other between two square cover-glasses. Either paraffin or duco-cement may be used to seal the pieces together. A paraffin membrane 120 microns in thickness was placed across the end of one of these compartments and gently pressed in position. The liquid, on which the leafhopper was to feed, was placed in this compartment, which was then sealed with another paraffin membrane. The distortion due to the highly curved surfaces of a drop was entirely eliminated by such a compartment. The compartment containing the liquid was sealed to a glass slide with a strip of paraffin ribbon. The open end of another compartment was pushed against the membrane on the liquid compartment. This formed a cage for the leafhopper having the paraffin membrane at one end and a cotton plug at the other. With this arrangement the leafhopper was forced to feed on its side which placed its mouth parts (when through the membrane) at right angles to the line of vision through the microscope. With the leafhopper feeding in this position the mouth parts can easily be seen in action under low or high power. It is an easy matter to see the coagulable material ejected at the tip of the setae bundle.

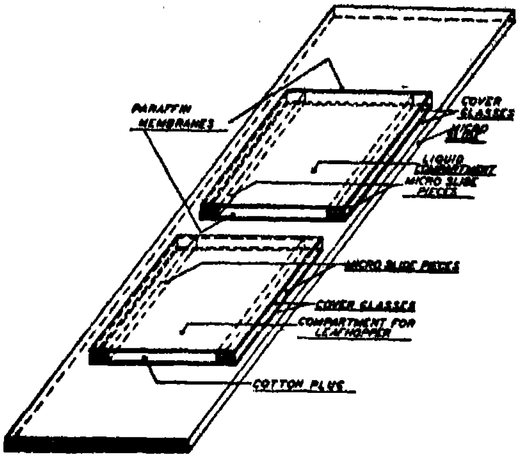

FIG. 2. Feeding device arranged to permit observation under the microscope of the sugar-beet leafhopper feeding upon the test solution.

These devices open up a wide range of interesting possibilities for study on the properties of the curly-top virus, the mechanics of feeding and the chemical nature of the leafhopper saliva. Detailed studies on the pH of the saliva of the sugar-beet leafhopper, which have been carried on as part of a study of the chemical nature of disease resistance in the case of the curly-top disease, will be presented later.

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SPECIAL ARTICLES

VISUAL PURPLE IN SNAKES

IN the extensive literature of the visual cells of vertebrates the reptiles appear to have had less consideration than other groups. Few species have been investigated, and these few have apparently been chosen because they were easy to secure and handle rather than because they were taxonomically representative. The forms which have been studied are chiefly members of the large families, and are too closely related and too similar in habits to form a basis for sweeping generalizations concerning the retinae of reptiles as a group.

Nevertheless, such generalizations have been made and the classic pieces of comparative ophthalmological literature concur unanimously in a summary to the following effect:

Crocodiles and their relatives possess both rods and cones; geckoes have only rods, "true" lizards and chameleons only cones. All snakes (except possibly *Boa constrictor*) and all turtles have pure-cone retinae. The situation in *Sphenodon* is in dispute.

Students of the retina seem satisfied to let these statements stand in spite of the fact that rods are necessary for scotopic vision and large numbers of reptiles (most of which are snakes) have vertically elliptical pupils—a feature which herpetologists have long considered a certain indication of nocturnal habit. The writer has felt that the entire reptilian group should be resurveyed with the application of modern criteria for the distinguishing of rod from cone, and has undertaken the histological study of the light- and dark-adapted retinae of a hundred or more species of reptiles chosen with proper regard to their light-habits and to their phylogenetic relationships.

While this histological program will of course form the bulk of the writer's work upon this group, rods and cones are not always easily distinguishable in sections. Since the most essential difference between them is the presence of the sensitizer, "visual purple" in rods and its absence in cones, an investigation of the distribution of this substance in reptiles was made as a highly desirable preliminary to the histological studies.

Briefly, the presence of visual purple in a dark-adapted retina is certain proof that functional rods are present, no matter what their form as seen in sections. Although this criterion was established fifty years ago through the great work of Kühne, no one has applied it widely to reptiles in which, considering their light-habits, one would be led to expect visual purple—and hence, rods.

Visual purple has been found in nocturnal geckoes and crocodiles, but only diurnal lizards and turtles have been examined for it, with negative results, and so far as the writer knows it has not even been looked for in any snake.

The writer has employed the following technique on a number of ophidian species: the animal is left overnight or longer in absolute darkness; by ruby light the snake is etherized or decapitated and an eye is removed. The excised retina is transferred to a depression slide in normal saline and covered. This slide, in a light-tight box with a white bottom, is then brought out into diffuse daylight where, after light-adaptation of the experimenter, it is opened in the presence of one or more additional witnesses. Visual purple, if present, is seen as a distinct pink, red or lavender coloration of the preparation which bleaches in a few seconds when taken near a window.

With this method visual purple was found in the following forms: Boidae, *Python molurus* and *Boa constrictor;* Colubridae, *Tarbophis fallax* and *Dasypeltis scaber;* Viperidae, *Agkistrodon mokasen, Sistrurus miliarius* and *Crotalus horridus.* All these forms have vertical pupils, and all except *Tarbophis* represent subfamilies all members of which have vertical pupils.

In four vertical-pupilled forms no visual purple was seen; in *Trimorphodon vandenburghi* (Colubridae), *Vipera berus* and *V. ammodytes* (Viperidae) the pigment epithelium refused to separate from the bacillary layer and as a consequence the retina was black macroscopically. In *Bitis arietans* (Viperidae) this trouble was not encountered, but visual purple was not surely seen, perhaps having been bleached by the ruby light during the excessively long time required for complete anesthesia in this case. The fresh *Bitis* retina, under the microscope, showed numerous slender cells with cylindrical outer segments (assuredly rods) surrounding large, plump cells (typical ophidian cones) whose outer segments had disintegrated in the saline.

No visual purple was found in round-pupilled forms, most of which are considered strictly diurnal by herpetologists. Some round-pupilled species are secretive and crepuscular and a few are called "nocturnal" in herpetological literature; examples are *Coronella girondica* and *C. austriaca, Micrurus fulvius, Lampropeltis t. triangulum* and *Drymarchon corais couperi* (all Colubridae). All these were examined with negative results; these and other forms may prowl at night, but the duplicity theory would lead us to pronounce them incapable of vision at night. They must hunt by other senses, perhaps olfaction, which is known to be acute in snakes.

From the above, together with the facts of distribution and significance of vertical pupils in reptiles, the writer does not hesitate to make the following statement: rods are to be expected, either to the exclusion of cones or in combination with them, in all Boidae, in all Viperidae[1] and in such Colubridae as have vertical pupils. Rods should be present in the Amblycephalidae and in *Xenopeltis*, but will probably not be found in any round-pupilled Colubrid.[2]

Most ophidian *species* are diurnal Colubrids, but most ophidian *families* are, bodily, nocturnal and have vertical pupils. Thus, in spite of the generalization seen in the literature, it is probable that rods are very wide-spread in snakes and that, from the phylogenetic standpoint, it is the pure-cone retina which represents the major departure from the beaten path.

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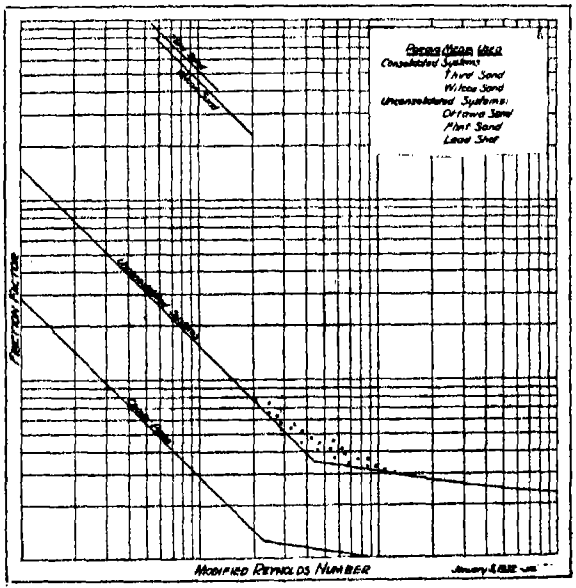
A NOTE ON THE FLOW OF FLUIDS THROUGH POROUS MEDIA

THE flow of fluids through porous media is being studied intensively in the Petroleum Research Laboratory of the Mineral Industries Experiment Station at The Pennsylvania State College.

Over 200 tests of the flow of water, air and crude petroleum through Ottawa sand, graded flint sand and six sizes of lead shot have been made as well as a few of the flow of water through consolidated sandstones. Of the latter, samples from cores of the Wilcox sand of Oklahoma and the Third sand of Venango County, Pennsylvania, were used.

The data have been correlated with the flow of fluids in circular pipes[1] by plotting a modified Reynolds number against a friction factor. Points so plotted for all systems of unconsolidated material define within the region of viscous flow a straight line parallel to that for circular pipes. Chilton and Colburn[2] recently found this to be true for columns packed with broken solids many times greater in mean diameter than the sand systems used in this work. A break in this line, or rather a region of change, is found with sand systems for large Reynolds numbers exactly as is the case for circular pipes corresponding to the change from viscous to turbulent flow.

It is remarkable that the flow of water through the consolidated sands studied so far, defines a straight line on this chart for each sand parallel to the lines for circular pipe and unconsolidated systems. The displacement evidently must be due to differences in composition and degree of consolidation of the sands. The illustration shows the type and relative displacement of the curves.



These experiments indicate that it may be possible to calculate energy relationships, permeability of oil-sands to fluids and similar factors germane to the production of petroleum from the properties of the fluid and the reservoir rock.

The investigation of the flow of fluids through consolidated porous systems is being studied in greater detail in this laboratory.

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JAMES A. LEWIS

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BOOKS RECEIVED

APPLETON, E. V. *Thermionic Vacuum Tubes.* Pp. 113. 68 figures. Dutton. $1.25.

DALAKER, HANS H. and HENRY E. HARTIG. *The Calculus.* Second edition. Pp. viii + 276. 107 figures. McGraw-Hill. $2.25.

JOHNSTONE, JAMES. *The Essentials of Biology.* Pp. xv + 328. 44 figures. Longmans, Green.

LANDMAN, J. H. *Human Sterilization.* Pp. xviii + 341. Macmillan. $4.00.

RICHARDSON, LEON B. and ANDREW J. SCARLETT, JR. *A Laboratory Manual of General Chemistry.* Revised. Pp. viii + 143. 23 figures. Holt. $1.50.

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[1] Except possibly the primitive genus *Causus*, which some writers state to have a round pupil and to be partially diurnal.

[2] Certain of the round-pupilled Elapines, such as *Naja* sp., may prove to have rods. The Cobras and their allies are in a state of confusion as regards their light-habits, as described by various authors. Even the matter of pupil-shapes in many Elapines is unsatisfactory, for authors who have observed living specimens disagree as to whether the pupil is round or a vertical slit!

[1] Walker, Lewis and McAdams, "Principles of Chemical Engineering," 2nd ed., p. 87, McGraw-Hill Book Co., Inc., 1927.

[2] Chilton and Colburn, *Ind. Eng. Chem.*, 23, 913–19, 1930.

SCIENCE

Vol. 75 FRIDAY, MAY 6, 1932 No. 1949

The Evolution of the Horticulturist: PROFESSOR T. H. MCHATTON 469

The George Eastman Research Laboratories for Physics and Chemistry: DR. KARL T. COMPTON 472

Obituary:
Albert Perry Brigham: RICHARD ELWOOD DODGE 479

Scientific Events:
Symposia at the Syracuse Meeting of the American Association; Nature Sanctuaries; Committee on Unemployment and Relief for Chemists and Chemical Engineers; Award of the Willard Gibbs Medal; Elections of the National Academy of Sciences 480

Scientific Notes and News 483

Discussion:
What is a Publication?: DR. TRACY I. STORER. *The Pathogenicity of Neisseria sicca:* DR. FREDERICK W. SHAW. *Chromosome Numbers in Althæa rosea:* GEORGE W. BURKETT. *On "Academic Freedom in Spain":* DR. JOSÉ F. NONIDEZ 486

Reports:
Recent Work on American Indian Languages: PROFESSOR FRANZ BOAS 489

Science Service Conference 492

Scientific Apparatus and Laboratory Methods:
A Critique of the Serial Dilution Method for Quantitative Determination of Bacteriophage: DR. A. P. KRUEGER. *A Simple Method of Rearing and Mounting Hookworm Larvae:* PROFESSOR F. S. ARANT and ROGER KNAPP 494

Special Articles:
Stimulative Effects of Illuminating Gas on Trees: DR. CARL G. DEUBER. *Observations on Taste Blindness:* DR. PHILIP LEVINE and DR. A. S. ANDERSON. *The Distribution of Caecal Spirochetes:* DR. MINNIE B. HARRIS 496

Science News 10

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THE EVOLUTION OF THE HORTICULTURIST[1]

By Professor T. H. McHATTON

GEORGIA STATE COLLEGE OF AGRICULTURE

IT was at the very dawn of our modern era, if we accept the historian's division of time, that Columella wrote:

> I can not enough wonder why they who desire to learn eloquence are so nice in their choice of an orator, whose eloquence they may imitate; and they who search after a knowledge of surveying and numbers look out for a master of the art they delight in; and they who are desirous of some skill in dancing and music are exceedingly scrupulous in their choice of one to modulate their voices or to regulate the motions of their bodies; also they who have a mind to build send for architects, masons and carpenters; and they who resolve to send ships to sea send for skillful pilots; they who make preparations for war call for men of war; and everyone sends for a person from the society and assembly of the wise to form his mind and instruct him in the precepts of virtue; but husbandry alone, which, without all doubt, is next to and, as it were, near akin to wisdom, is in want of both masters and scholars.

One who peruses the voluminous writings of Columella can but marvel at the keen insight he displayed concerning things agricultural and horticultural. So true was his statement that rural culture was looked down upon that this history of the very heart of Rome, this economic treatise of the times, has been pigeonholed and forgotten by the very ones who should have used its gems of living philosophy in expounding the humanities that they so loudly preach are necessary in cultivating the human mind. Even in the time of Columella, agriculture and horticulture were as teachable as any other subject of the period, but, because the luxury-loving landlords saw fit to abrogate their responsibilities and to delegate the tilling of the soil to their less intelligent servants, agriculture became a sordid occupation and man saw little in it but sweat and toil. He lost sight of that cycle of life of which the soil is the basis; and there came to pass that condition of affairs so greatly feared by our wise philosopher; that is, agriculture had indeed become a sordid occupation, and now, nearly 2,000 years later, there are still living among us those who do not yet realize that of the words agriculture and horticulture, more than half are "culture."

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[1] Presidential address before the American Society for Horticultural Science.

History is of little value except in helping one predict the future. It took men almost twenty centuries to grasp some realization of the importance of agriculture, and it has taken the greatest economic crisis in the history of our world's civilization to crystallize that realization. I sometimes wonder if the phrase that we have heard so often repeated during the past twenty years concerning the "drudgery in the home" is the forerunner of a system of thought that will cause the abrogation of responsibilities and fetter man for another 2,000 years or more.

Horticulture was an amateur calling from the days of Columella to the middle of the nineteenth century; and even yet amateurs are occasionally found among apple and pear trees, or in gardens near cabbages and carrots, sometimes on lawns near clumps of shrubs or beds of flowers from whence they peep out upon the world with bright and shining eyes filled with happiness and contentment, their voices mellowed with the love of nature and the philosophy of living. It is a pity that the age of "internal combustion" has so beset them with "ologies" that they have practically disappeared, and unless the few remaining are carefully protected, this species will soon be counted with things historic.

This benign type of individual was so common during the middle of the nineteenth century as to deserve the name "vulgaris." Ever since the days of Rome they had been on the increase, receiving something of a setback during the "Dark Ages," but after that period of depression they emerged from the monasteries and rapidly increased in number, laying the basis for the establishment of schools and trades in Europe and the development of such aggregations of congenial souls as the American Pomological Society in this country.

These early amateurs were building the foundation of our profession and producing cyclopedic writings and rule books of culture in large numbers; so also were their close associates, the general farmers, laying the bedrocks from which were to spring much of our present-day agriculture.

Let us view for a moment the situation in this country about the middle of the nineteenth century. At the end of the seventeen hundreds this nation was mainly rural and producing just about enough for its needs, exporting some tobacco, cotton and rice. Horticultural products were all home grown and had only a very limited local market. Following the invention of the cotton gin, the opening of canals, the development of the railroads and the disruption of world economic conditions through the Napoleonic wars and our own War of 1812, commerce and industry developed. Thus we find the East industrialized, the South agricultural and the free lands of the West rapidly developing into a great grain and animal section. Agriculture had gone through the stage of home consumption, and the horticulturists were catching glimpses of extensive orchards and gardens in the future. Protective tariffs had been passed and the conflict between agriculture and industry had already brought on the Civil War, and the same conflict may, in the near future, bring some other great cataclysm to this nation.

Such conditions brought rural problems to the forefront in the minds of thinking men; mayhap they sensed the great industrial-agricultural conflict that was on and caught a glimpse of its future magnitude. Be that as it may, the Congress of the United States, in the midst of national strife, legislated into being a system of education that, through the land-grant institutions, would pay its dividends during the time of peace. Thus after eighteen hundred years was the lamentation of Columella fully answered—there were to be scholars and teachers of agriculture.

If 1870 is accepted as the approximate date at which these institutions really began to function, it is only fair that some estimate be made of what horticulture was at that time. Though there had been efforts at instruction in this subject in Europe and a few in America, the handling of it had been along apprenticeship lines; the teaching of a trade by rule of thumb, based upon a literature consisting of calendars and catalogues of varieties. Professional horticulturists, if we might call them that, were really managers of estates, or florists and gardeners about large centers of population. There were many amateurs and some several nurserymen also interested in the subject purely as home projects.

When one realizes that at the time of the passage of the Morrell Act botany and zoology were still in the systematic stage; bacteriology had not yet been born; genetics was still philosophy; and organic chemistry, though a lusty infant clamoring for recognition, had made little impression in learned circles; that physics had progressed mechanically, but the realms of heat, light and electricity largely remained unexplored; that the biochemist, the biophysicist, the soil scientist, the phytopathologist, the entomologist and many others had not yet come into being; it is easy then to understand the attitude of the academic mind when horticulture and other allied agricultural subjects were raised to the dignity of a college curriculum. Such subjects were not teachable in universities, as they were not based on well-organized information and backed up by a literature centuries old—besides, they were merely trades and had no right to academic standing.

In the main this was largely true and was reflected in the organization of institutions with standards considerably below those set by the humanities. In the older states, already supplied with higher education, these new colleges were established separately; in others, they were connected with the budding university, and in still others they were destined to be the hub around which great institutions were to develop. In the beginning, they all had the ideal of preparing artisans in horticulture. The students were to go back to their orchards and gardens, increasing their production and bettering the living conditions throughout America. It was natural that such ideals should prevail, as there were really no well-established, well-understood horticultural facts; science had not, as yet, removed our profession from the realm of astronomy.

Things did not happen, however, as anticipated; departments rapidly expanded and demanded these trained artisans as teachers, and gradually there developed a different ideal of horticulture. The period of 1870–1890 was one of great activity in our field. The constant search for well-established facts and their organization into a body of teachable matter developed above all else the great fact that little was known. So noisy was the clamor for definite information and its dearth so apparent, not only in horticulture, but along all agricultural lines, that the Hatch Act found its way through the hoppers of Congress and gave us a new ideal of what a horticulturist could be.

Between 1890 and 1910, many more things happened to change our ideas of horticulture. The public still expected the product of the college to be an artisan, while the colleges themselves, the experiment stations and the rapidly expanding national Department of Agriculture recognized the demand for experimenters, teachers and scientists. The amateur was rapidly disappearing. There was, of course, still a lot of interest in the production of quality fruit about the homes, but the development of refrigeration and the railroads, into what we then considered rapid transportation, reorganized our industry. Extensive orchards spread themselves throughout California and the South; the vast vegetable fields of Texas and of Florida had begun to pour their out-of-season products upon the markets of the East. The experiment stations had amassed an enormous number of facts and the inquiring minds of the profession were asking questions that were vitally more fundamental than the date of planting or pruning. The sciences had taken hold of horticultural problems. Pasteur, Koch and others had conjured bacteriology into being. The problems of evolution had become things of every-day discussion. Botany had slipped from its classification era into embryology, physiology and more basic discussions. At the beginning of the century the work of Mendel had been resurrected from dusty archives, and horticulture was launched into its economic and scientific being.

In academic centers science was fighting the humanities for its place in the sun, and it was during this era that there came into being that new species called the "pure scientist," unsullied and untouched by practicality, but willing enough to use the public monies, appropriated so that science could render more productive and remunerative the basic industries of the nation. It is well to remember that the scientists who have written their names across the pages of history have been those who had advanced mankind and relieved humanity of its burdens. They are honored in direct ratio to the advancement civilization has received from their discoveries. All science is pure: it matters not whether it is digging into the sewers of a great city or studying the elusive perfume of a spotless lily.

During this period, the Adams Act came into being. We then found ourselves launched upon definite scientific studies, and, if we look back upon this time, those of us who were in it can well remember the trials and troubles we had in organizing experimental work upon a scientific basis. To my mind the passage of the Adams Act was one of the most beneficial things that has happened to the profession of horticulture as a whole. This act again changed our ideal of a horticulturist. The experimenter had become a scientist even more than a fruit grower, and for a while we laid away the idea of simple demonstrations, but this was not long, for it was realized that valuable information was not getting back to the farms where it could be profitably used and the Smith-Lever Act was the result.

This was rapidly followed by the Smith-Hughes Bill; a response to a demand for farmers and fruit growers on the soil which it was finally seen could not be met by the colleges, as estimates show that a large rural state requires in round numbers 4,000 new farmers annually. These acts brought into being other species of horticulturists, namely, men with scientific training and practical ability who could teach in secondary schools or by demonstration in the rural districts and thus get back to the country information that it really needed. Also during this period of 1910–1920 the commercial horticulturist came to the forefront. He was found with railroads, spray companies, fertilizer companies, machinery companies, marketing organizations, and the like.

Since 1920 specialization has increased, and with the passage of the Purnell Act the economist has become important, injecting into our already complex organization other demands. Industry, in its selfishness and under artificial stimulation, had turned the United States from a rural into an urban nation, and the great industrial-agricultural conflict had practically throttled farming in its various forms before a realization was attained that the power, wealth and balance of trade of this country were in reality dependent upon the products of its soil and the labor of its rural population, which had for decades been producing against an impenetrable barrier of protection, for other interests, and forced to sell in open competition on the markets of the world. Is there any wonder that since 1920 the economical production and handling of our horticultural products have become prominent in our thoughts? The horticulturist can look with pride upon the fact that of the brotherhood of agricultural subjects his was the first to realize the importance of coordinating individual effort in projecting better methods of handling farm commodities; and, out of this experience of more than a quarter of a century, there should come to him the realization that he is better able to maintain himself under stress of modern conditions than other members of the rural fraternity; even though his advice has neither been sought nor listened to in the formulation of schemes and the passage of legislation intended to control the immutable laws of economics. It is a great pity, my friends, that money is not endowed with brains as well as power.

THE GEORGE EASTMAN RESEARCH LABORATORIES FOR PHYSICS AND CHEMISTRY

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

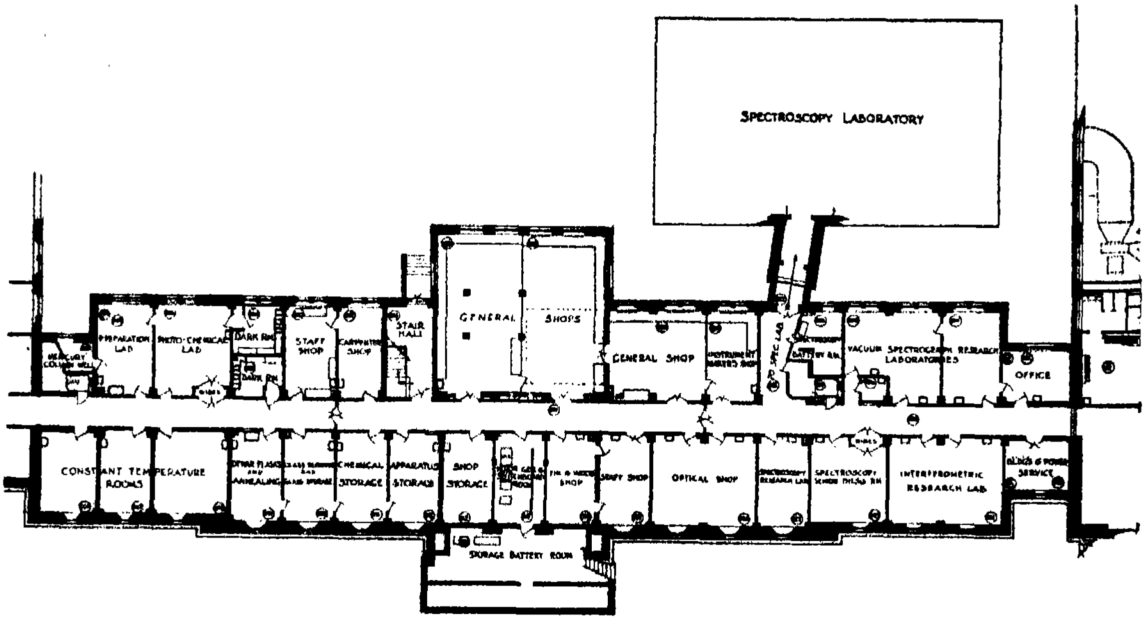
THE new research laboratories of physics and chemistry, which are now nearing completion at the Massachusetts Institute of Technology, are built in the belief that these fundamental sciences are destined to play an even more important rôle in our civilization than they have played during the past, for not only do they underlie all branches of engineering, but they are necessary to that sympathetic understanding and appreciation of modern life which is so important a part of present-day culture.

These laboratories are devoted entirely to advanced instruction and research and embody the most approved features, together with numerous new features of laboratory design. Briefly stated, these features are: rigidity and freedom from vibration; flexibility and completeness of electrical service; flexibility of internal arrangements; unusually adequate shop, lecture room and departmental library facilities; and provision for encouraging, in a cultural and artistic setting, social contacts among staff and students.

The spirit and purpose of the laboratories are typified by the three marble panels which are set into the limestone walls just above the main entrance to the laboratories. To the left, which is the chemistry side of the building, is a medallion taken from a block medal showing the head of the young scientist, Jacobus Henricus Van't Hoff, discoverer of the important principle of molecular asymmetry, which is represented on the medallion by two tetrahedra, one the reverse of the other. To the right, which is the physics side, is a medallion of Sir Isaac Newton with an inscription epitomizing his three laws of motion. Between these two panels is a third containing a Latin quotation from Vergil, which may be translated literally as follows: "Happy is he who has been able to learn the causes of things and has cast beneath his feet all fears and inexorable Fate and the roar of greedy Acheron."

GENERAL ARRANGEMENT OF THE LABORATORIES

On entering the building, which is about 300 feet long and five stories high including basement, the chemistry laboratories are found on the left, the physics laboratories on the right, and in the center of the building are found successively, going from basement up, the shops, switchboard, generator and battery rooms, main lecture room, directors' offices, class rooms, departmental library, reading room and social room. Connecting with the physics side of the building is the special new spectroscopy laboratory of unique design for convenience, freedom from vibration and temperature control. This spectroscopy laboratory, which is now in use, is to be described separately in another article.



BASEMENT FLOOR PLAN

SCALE IN FEET

On the chemistry side, the basement and the first and second floors are assigned to physical chemistry, the third and part of the fourth floors to organic chemistry, and the remainder of the fourth floor to inorganic chemistry.

On the physics side, the basement is assigned to spectroscopy, supplementing the work in the main spectroscopy laboratory. The first and second floors are assigned to research in electronics and gaseous conduction. The third floor, which contains also the library, reading room and social room, is divided into a series of large and small offices for research in theoretical problems. The fourth floor is planned for work in x-rays, dielectric and other properties of matter, and contains a room with suitable communication through the roof for optical testing and work with the spectroheliograph which has been presented by an alumnus, Dr. George Ellery Hale, honorary director of the Mount Wilson Observatory.

The building connects at its two ends with other units of the main educational plant of the Institute and is in close proximity to the departments of electrical engineering and mining and metallurgy on the physics side, and to the departments of mathematics and chemical engineering on the chemistry side, and at the same time is closely adjacent to the regions in which the undergraduate instruction in physics and chemistry is carried on.

LABORATORY SERVICES AND SPECIAL FEATURES

Entrance Lobby and Corridors: The building is entered through carved teak doors into a large lobby whose walls are covered with Italian travertine. To the right and left are to be placed semi-permanent exhibits relating to physics and chemistry, and statues of two prominent scientists will flank the few steps rising from the entrance lobby to the main corridor. This corridor, like those on the other floors, is divided into three sections by fire doors which may be closed in emergency. The central section on the first floor is also finished in Italian travertine and has a false ceiling which conceals the overhead piping. In the other parts of the corridors the overhead piping is exposed but is so high as not to be objectionable.

Lecture Hall: Facing the entrance lobby is the main lecture room, with 195 seats which are raised, stepping up toward the back of the room in such a way as to provide space for an ample coat room beneath the rear seats and platform. The room is finished in travertine dado at the lower level, with California stucco above, and the ceiling is acoustically treated. In the rear is a completely equipped projection room for a double sound motion-picture installation and a stereopticon with automatic slide control, operated from the lecture table. Blackboards extend clear across the front wall with a sliding central section which is electrically operated. Above the blackboards are a loud-speaker and large multirange voltmeters and ammeters. Beneath the central blackboard is a very complete switchboard furnishing a great variety of electrical services to the lecture table, the electrical meters and the projection room.

The main lecture table is by far the most expensive and complicated piece of furniture in the building. About fifteen feet long, it has a sink at each end with gas, distilled water, compressed air, cold water, and steam outlets. From this table and the panel under the blackboard run controls for the automatic window shades, phone, signal and operating wires to the picture booth, lights and dimmer control, demonstration electric meters, timer, and sets of rheostats for regulating currents through the entire range up to 2,250 amperes. All electrical service available anywhere in the building is wired to the lecture table.

This unusually complete lecture room equipment has been designed with the assistance of Professor P. Scherrer, of the University of Zurich, who is internationally noted for the excellence of his lecture demonstrations and equipment.

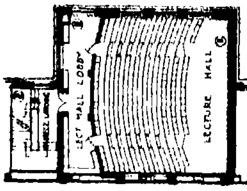
Shops: Realizing that the limitations of accomplishment in experimental research are often set by limitations of shop facilities, no effort has been spared to make the equipment and arrangement of the shops as nearly ideal as possible. The physics glass blowers' shop is located on the second floor, adjacent to the research stock room and close to one of the elevators. The remaining shops are located in the basement.

The main machine shops are located directly below the lecture hall. The chemistry shop occupies the left and the physics shop the right-hand side of this space, and the two are divided by an open iron grill. This separation into two shops is made in order to fix the respective responsibilities of the mechanicians attached to the two departments, but unnecessary expense due to duplication of equipment is avoided by the close communication between the two shops which enables machine tools of a type which are needed only occasionally to be shared by the two groups of workmen. The physics shop also extends into the adjacent rooms and includes an instrument maker's shop provided with small tools of extreme precision. Across the hall is a staff shop, an optical shop and a "tin and wood shop," which really means a shop for miscellaneous work of a type which is undesirable in the main shops. Similarly, on the chemistry side is a staff shop, carpenter shop and glass blowing room, together with a room for storage of shop materials.

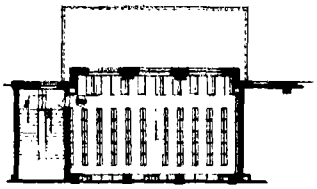
A very interesting feature of these shops is the provision which has been made to prevent the generation of vibrations and their transmission throughout the building. All of the smaller machine tools are mounted upon anti-vibration bases of the most approved type. For the larger machine tools, notably the large miller, shaper and grinder, a new protection against vibration has been installed with the assistance of Dr. Gerke, of the U. S. Rubber Company. Under these machines a pit of a depth of about two feet was left in the 3½ ft. reenforced concrete mat which underlies the entire building. On the bottom of this pit is laid a one-inch layer of the finest quality of sponge rubber of such a type as to be compressed to about nine-tenths of its original thickness under the weight which is to be loaded on it. This rubber is covered with a waterproof layer of transite board, on which is then put a solid reenforced concrete block, rising to the level of the surrounding floor. The sides of this block are separated from the surrounding floor by a similar layer of sponge rubber. The machine tool is then mounted on this sixty-ton concrete block with the aid of the ordinary anti-vibration protection. Thus the machine and its concrete base float on the sponge rubber. The theory of this installation is as follows: The mass of the machine tool and the elastic properties of the anti-vibration base, by which it is attached to the concrete, form such a combination as to transmit only a certain natural frequency of vibration into the block. The combination of the mass of the block and the elastic properties of the rubber on which it floats are such as to give this system a natural frequency about ten times smaller than that which is being fed into the concrete block. The system therefore acts as a double by-pass which effectually prevents the transmission of any vibrations to the floor of the building. Each of the three most important heavy machine tools is mounted in this way.

Offices: The offices of the director of the chemical laboratory and the two directors of the physics laboratory are located on either side of the entrance lobby, and every attempt has been made to make them attractive as well as convenient in order that they may promote the feeling that the pursuit of science has its cultural and human aspects as well as those aspects of efficiency and accomplishment which are the chief impressions gained from the shops and laboratories.

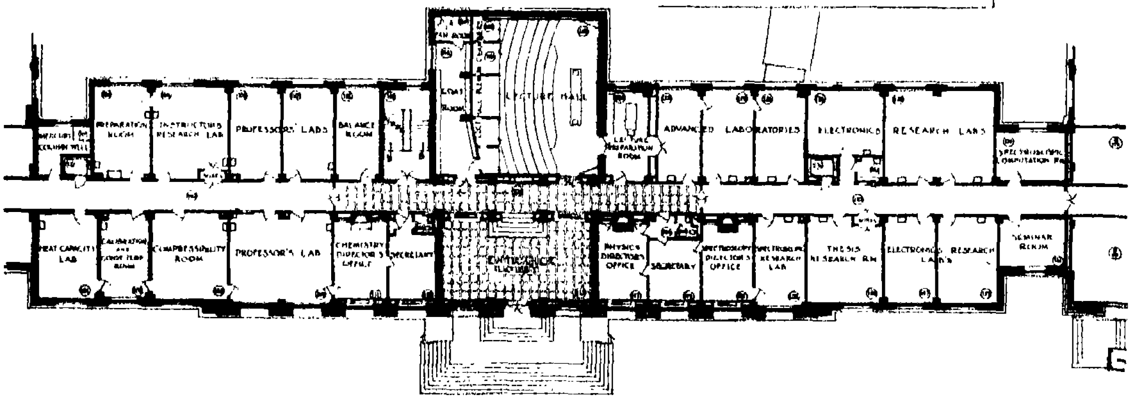
Through the generosity of Mrs. F. Jewett Moore, who has provided a fund for making the study of chemistry and its surroundings more interesting and attractive, the office of the director of chemistry has been given special architectural treatment. The walls of this office are paneled ten feet high in oak, with a rough textured tinted plaster above. The ceiling is arched and paneled in the English manner with raised mouldings. The large window is broken up with moulded mullions and transoms into small units set with leaded glass containing Lallique plaques. Opposite the window is a fireplace trimmed with limestone, and over it is the inscription: "Felix qui potuit



LECTURE HALL MEZZANINE PLAN



BOOK STACK MEZZANINE PLAN



FIRST FLOOR PLAN
SCALE IN FEET

rerum cognoscere causas." Above the mantel there is space for a painting, and on either side there are built-in bookcases. The floor is of oak, laid in parquetry design. The complete furnishings of the room are being given the attention and thought required to secure in this room, through its harmonious blend of line, color and arrangements, an atmosphere suggestive of the high aims and purposes to which the new home for science is dedicated.

On one side of the director's office is the departmental secretary's office, while on the other side is the director's laboratory.

The physics offices of administration are more simple, yet comfortable, dignified and interesting in design. They are finished in California stucco of a warm color, with raised wood mouldings forming large panels. The cornice and chair rail are of wood, painted to match the buff walls. Each room has a fireplace at the end opposite the window, and the fireplace is flanked on both sides with built-in bookcases. The floors are of wood, and the ceilings are acoustically treated with acousticelotex.

The remaining offices have the ordinary inside finish of the rest of the building. Of particular interest is the group of offices adjoining the departmental library, reading room and social room on the third floor. On the front of the building are larger offices, each provided with a built-in blackboard so that they can be used on occasion by students for conferences and seminars, while to the rear of the building are a group of small offices for graduate students and research fellows who are working on theoretical problems.

On the chemistry side of the building are several professors' offices with their special laboratories adjoining, including especially one such suite especially designed for guest professors.

Physics-Chemistry-Mathematics Departmental Library: Immediately above the lecture hall is a book stack-room with floors on two levels, one being the level of the third floor and the other the level of a mezzanine floor below. These two floors of stacks can accommodate approximately 40,000 volumes. The two floors of this stack-room also contain a series of cubicles beside the windows, in which are seats and desks where men who desire continual convenient access to the stacks may carry on their work.

Opening into the book stacks is a large reading room with a rubber tile floor, tinted green stucco walls, an acoustically treated ceiling, comfortable furniture, and reference books and current periodicals conveniently located around the walls. The effort has been made to make this room an attractive working space for the study of research problems. Beside the entrance to the reading room is the library file and the desk of the branch librarian, who is in charge of this library and is at the same time a member of the staff of the central library of the Institute. This branch library is designed essentially as a "working" library rather than as a depository, and in it will be found only such books, periodicals and treatises as are of importance in connection with research work.

Norris Jewett Moore Room: Still further to promote cooperation and intercourse among the men who will be working on their special problems in this building, a social room of unusual attractiveness and convenience has been located just opposite the library. This room, whose equipment and furnishing has been made possible through the generosity of Mrs. Forris Jewett Moore, is to be named the "Forris Jewett Moore Room" in honor of her late husband, who was professor of chemistry at the Institute from 1902 to 1925, and who was unusually interested in the human side of scientific work.

This room is furnished like a home or a club, with rugs, curtains, comfortable chairs and sofas, tables with shaded lamps, set in a background of oak paneled walls, a heavy timbered ceiling, a parquetry floor, and a carved stone fireplace. There is space on the walls for a few fine paintings, notably one of Professor Moore himself.

In addition to its customary use for reading or conversation, this room will be used on the occasions of the weekly physics colloquia, special conferences, and lectures by distinguished visiting and foreign scientists. For the social gatherings before and after such functions, as well as for the use of those who are accustomed to enjoy a few minutes away from their work in the afternoon for the purpose of recreation, thought or intercourse, a fully equipped kitchenette is provided, adjoining the social room, in which tea or other refreshments may be prepared.

Special Rooms: In addition to the rooms mentioned above, the following are suggestive of some of the facilities of the laboratory. There is a mercury column well extending the height of the building. There are two passenger elevators, one on each side of the building. Freight elevators are available in the buildings, connecting with each end of these laboratories. There is a constant temperature room for the calibration of instruments, and another group of large constant temperature rooms is provided in the basement. There are several photographic dark rooms. One room is being particularly equipped with mechanical aids for computation.

Electrical and other Services: The electrical current used in the laboratories is derived principally from five sources, all fed ultimately from the power plant of the Institute. The large transformer and motor generator sets are located in closely adjacent buildings in order to reduce vibration hazard. In the room below the steps of the main entrance are two storage batteries. One is of 240 volts subdivided into two 120 volt units, one of which acts as a ballast across the 120 volt motor generator set. The other battery is also 120 volts and is subdivided into ten 12 volt units which can be connected in any combination of series or parallel arrangement by making suitable connections on a mercury pool-in-marble switchboard. Beside the opening of the passage into the spectroscopy laboratory is still another 120 volt storage battery of very large capacity, designed particularly for use in the spectroscopy laboratory but also wired to a series of outlets on the physics side of the basement of the main laboratory. On the fourth floor of the physics side is installed a 100,000 volt stabilized direct current generator for x-ray and other uses. Finally, in order to have certain sources of current available for the exclusive use of an experimenter whose work would suffer if other people were to tap in and out of the same current source, a number of small motor generators of different types have been located in the switchboard room, all running on 3-phase, 220 volt current, and each arranged so that only a single load can be taken from it at a time. These generators provide 110 volt d. c., 110 volt 500 cycle a. c., etc.

Each research bay on the physics side is provided with 120 volt a. c. outlets at convenient positions and, in addition, is provided with a switchboard containing the following outlets:

240 volt, 3-phase a. c.
240/120 volt, 1 phase, 60 cycle a. c.
240/120 volt d. c.
700/350 volt d. c.
2 60-ampere lines running from the central distributing switchboard.
8 signal lines running throughout the laboratory.

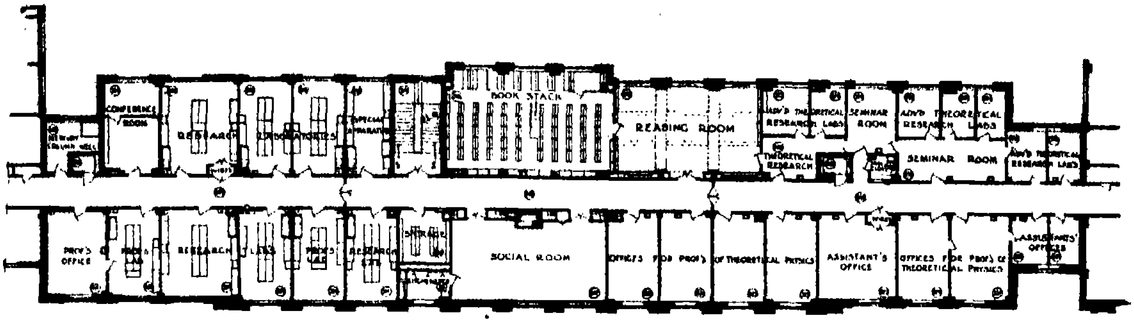
On the chemistry side each research bay is similarly equipped except for omission of the 700/350 volt line.

The main electrical control and distributing switchboard is located in the basement of the building below the entrance lobby. A separate switchboard is placed beside the special storage battery for the spectroscopy laboratory and intermediate distributing and fuse boards are located in the hallway on each floor, near the center of the physics and of the chemistry sides of the building. Altogether there are 1,100 lighting outlets, 1,400 experimental outlets and about 70 miles of wiring in the building.

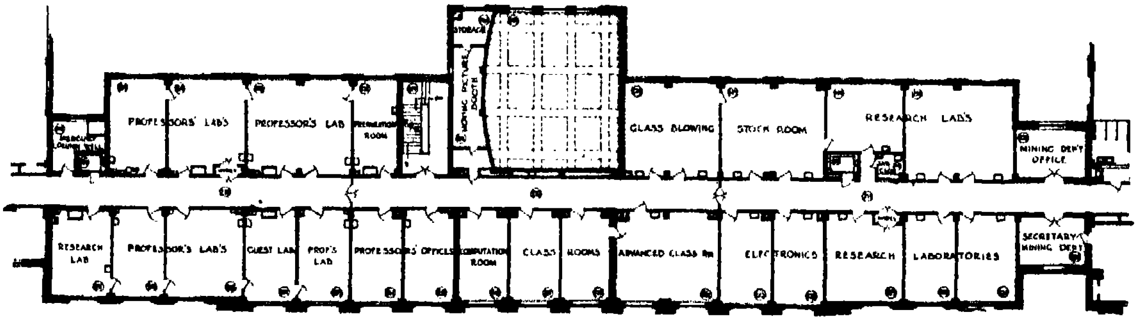
Hot and cold water, gas and compressed air are piped to all research bays, and distilled water is piped to all bays in the chemistry laboratories and to a few selected points on the physics side.

The ventilating hoods on the chemistry side are provided with individual forced draught for each room, the discharge vent being located on the roof.

Forced draught ventilation is provided in the lecture, class, library, and seminar rooms, but not in the individual offices or research rooms, which will depend upon the adjustment of casement windows and of steam radiators for temperature and ventilation control.



THIRD FLOOR PLAN



SECOND FLOOR PLAN

SCALE IN FEET

Special Equipment of the Chemical Laboratories: Except for the work in spectroscopy, which is separately provided for in the new spectroscopy laboratory, the research rooms on the physics side require no further description, since the facilities already described are adequate for the installation of all types of physical research which are now contemplated, and for which appropriate apparatus will be installed as needed. On the chemical side of the building, however, there are certain additional features of a permanent nature which deserve special mention.

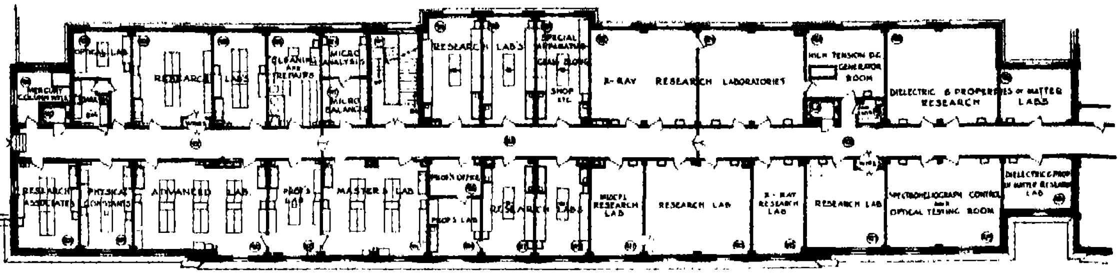
In the laboratory of physical chemistry there will be installed a 70 foot, jacketed, mercury column, provided with a special well so that precise measurements involving the application of high pressure may be carried to pressures of several thousand atmospheres.

A special constant temperature room will contain rather elaborate equipment for gas thermometry and platinum resistance thermometer standards, and will be accessible for calibration at all available temperatures of the various types of secondary thermometers used throughout the laboratory. A similar room will contain very complete equipment for the measurement of volumes and the temperature dilation of materials at atmospheric pressure. In the same room will be installed apparatus for measuring the two principal elastic constants of materials over long ranges of temperature. This same room will also contain standard cells and calibrated standards of resistance and resistance bridges to serve as standards for the measurements of energy, which are usually carried out by electrical means. All calibration and wiring diagrams will be framed and hung on the walls beside the apparatus.

A special balance room, which will be maintained at substantially constant temperature, will contain complete standard equipment for weighing masses from 5 kilograms to 5 micrograms. The standard and calibrated weights for these ranges are to be kept in cases in this room.

Various rooms devoted to investigations of gaseous and other equilibria, of van der Waals' forces, or molecular attractive and repulsive forces, of problems in photochemistry, and measurements pertaining to heat capacity, are all being especially equipped and are located so as to secure a maximum degree of coordination between these related fields of investigation.

In the space allotted to organic chemistry on the two upper floors, there is one room specially designed for optical work with spectrographs, polariscopes, refractometers, and an adjacent dark room. A second room is being equipped for the determination of physical properties, molecular weights, electrical conductivity, and volumetric analysis. A third room is being devoted to micro and semi-micro methods of



FOURTH FLOOR PLAN

SCALE IN FEET

analysis, and a fourth room contains a large electrical centrifuge, vacuum drying ovens, an ozonizer, autoclaves, high and low pressure hydrogenation apparatus, and a bench supplied with tools for simple mechanical work. This room also contains jacketed kettles for cleaning apparatus.

Throughout the chemical laboratories built-in desks with all necessary facilities and services have been specially designed. These will be supplemented by portable apparatus on wheels such as special vacuum pumps, storage batteries, measuring instruments, thermo-regulators, etc. Similar provision, primarily for the physics group, is being made for portable services such as high-frequency induction heaters, specially isolated portable batteries, and similar apparatus which may be mounted on rubber-wheeled trucks and taken from place to place as desired.

Special Architectural and Structural Features: Any modern laboratory must be rigid in construction, flexible and convenient in arrangements. In order to serve its purpose in an educational institution it should also be attractive and contain those intangible features which lead to better understanding of the ideals and the aims as well as the methods and particular difficulties of the various branches of the physical sciences.

In appearance this building carries out the same design as the main educational group at Massachusetts Institute of Technology. The entire front is of Indiana limestone with a granite grass course. The large windows are a combination of casements and top hung vents surrounded by fixed panes.

Since the subsoil at this location consists of fill and organic silt averaging 12 feet in thickness at the northerly end and 21 feet in thickness at the southerly end, all resting upon glacial drift of sand, and since there are traffic disturbances in the neighborhood, great pains were taken in the design and construction in order to insure a high degree of rigidity in the structure. About 2,800 piles support the building. At the northerly end these are stopped in a bed of compact gray sand, while at the southern end where the sand layer is too thin to afford support to the piles, much longer piles were used and embedded about 25 feet into the bed of clay which underlies the sand and fill.

The foundations are in general designed as separate footings but the spaces between the footings, where they occur, are filled with concrete and reenforced with rods extending into the footings, thus tieing the entire foundation together and making one huge reenforced concrete mat on which the entire structure is erected.

The main walls and the floors are of reenforced concrete. In addition to the dead loads, which are exceptionally heavy, the live loads are as follows:

Roof	50	lbs. per sq. ft.
3rd and 4th floors	75	" " " "
2nd floor	125	" " " "
1st floor	150	" " " "

All columns, girders, floor beams, longitudinal corridor beams, and floor slabs are made larger and stiffer than usual in order to increase rigidity.

Except for the solid concrete transverse partitions, which were introduced for additional stiffening, the remaining transverse partitions consist of gypsum blocks with plaster finish. These partitions can be readily drilled and can be readily knocked out or rebuilt if future uses of the building should require a change in the present location of partition walls.

The floors are of terrazzo, the ceilings of exposed concrete, and the finish is of stained birch. The door frames and window frames are of pressed metal. A pipe sleeve is provided in the floor of every bay and in the partition wall between every two adjoining rooms in order to permit the temporary drawing of wires or pipes between adjacent rooms on the same floor, or one above the other, thus facilitating types of intercommunication which have not been provided in the regular equipment of the buildings.

All horizontal piping and all fittings on the chemistry side of the building are of chemical resisting Duriron. All other piping is cast iron, except for the distilled water, which is carried in block tin pipes. Sprinklers are installed in the corridors only, since the building is entirely fireproof and the damage which might be caused by water in an experimental room is probably greater than that which could be caused by fire.

All piping, all power conduits and all the fume ducts are run exposed so that they may be easily added to, repaired, or changed. Ceiling heights are such as to render this exposure unobjectionable. The exceptions to this are in the main entrance hall in the center of the building and in the permanent lecture rooms or offices and library, in which cases the piping is concealed.

It is expected that the final cost of the laboratories will be approximately $1,146,000, including architects' and engineers' fees and an allowance of $125,000 for laboratory tables, furniture and shop machinery. If the cubage of the building is figured to the bottom of the mat over the tops of the piles, it amounts to 1,367,000 cu. ft., from which the cost of the building and equipment is estimated at $.83 per cubic foot. The building will be completed in May and the research apparatus will be moved into it during the summer, so that it is expected to have the laboratory in full operation beginning with next October.

The funds for the building were provided in a gift by Mr. George Eastman for educational buildings when needed, with the proviso that these funds could be used as endowment until the buildings were needed. Mr. Lammot du Pont has contributed an amount equal to the interest on the cost of the building for two years, in order to expedite its construction.

The architects of the building were Coolidge and Carlson. The engineers were Charles T. Main, Inc. The building committee consisted of Everett Morss and Charles T. Main. All construction work was carried on under the direction of Stone and Webster.

OBITUARY

ALBERT PERRY BRIGHAM

ALBERT PERRY BRIGHAM, geographer, geologist, educator and humanist, died in Washington, D. C., on March 31, in the seventy-seventh year of his age. Born in Perry, New York, on June 12, 1855, and surrounded in his youth by the rich fossiliferous horizons of the Genesee Valley, what was more natural than that his alert and inquiring mind should be early aroused to an interest in geology. Later, having the good fortune to attend a series of lectures in geology in his college days, given by a man with keen insight into nature and with a rich philosophy, Brigham's interest in the subject was deepened.

But it was many years before he could yield to the urge and enter into training for what proved to be his life work. After graduating as valedictorian of his class and with high honors in classics, he trained to be a minister, and for nearly ten years was a successful pastor in Stillwater and Utica, New York. That pastoral duties did not check his following his avocation is indicated by the fact that his first paper, entitled "The Geology of Oneida County," was published in 1888, three years before he resigned his pastorate and entered the Harvard Graduate School.

This turning point in his career was the result of his experience in a summer vacation in 1889, when he attended the six weeks' Harvard field course in geology. Here he came under the influence of those master teachers of their day, Nathaniel Southgate Shaler and William Morris Davis, who, with Robert Tracy Jackson, the paleontologist, were later his teachers in his year at Harvard. Here, in a group which included Tarr, Westgate, Marbut, A. H. Brooks, Ward and the writer, he first had his interest aroused in physiography of the lands and for several years Brigham's publications and public addresses were largely devoted to physiographic topics.

Returning to Colgate University, his alma mater, as professor of geology in 1892 and until his retirement in 1925, he taught many generations of youth geology and geography, and, what is more, so gained their confidence and affection as to be a vital influence in their lives. With the eagerness of youth, which abided through life, Brigham at once began to be of the widest service to his science. A clear thinker, vigorous and fearless of speech, with a personality that won the confidence of his hearers, Brigham soon became in demand as a speaker to audiences of teachers and laymen. A regular attendant and contributor at professional meetings, his reputation grew apace, and when the Association of American Geographers was formed in 1904 it was just as natural to turn to Brigham for the secretaryship as it was to make the founder, Professor Davis, the first president.

For nine years Brigham guided the destinies of this little group of geographers who were bound together only loosely by any common interests. He contributed regularly to the programs a series of papers which indicate the gradual transfer of his major interest from physiography to economic geography and later to the human side of the subject. He also found time to take an active part in the work of the New York State Science Teachers Association, serving one year as president, and for eleven years was chief examiner on geography for the College Entrance Examination Board. He was also examiner for the New York State Education Department for several years.

These many duties did not interfere with his productive work, as is indicated by the fact that more than eighty major titles in science and education have come from his pen in the last forty-four years. These include articles on geology, geography and education and books for young and old in a wide field. High-school texts in geology, physical geography, with G. K. Gilbert, commercial geography and a series of elementary school texts, with C. T. McFarlane, were supplemented by books in the relation of geography and history and culminated in his volume on the United States based on a series of lectures at London.

For fourteen years Brigham taught in summer schools in this country and for five in England. He attended and took part in several geographical congresses and visited Europe many times. His acquaintance was wide and his many and varied contributions to all phases of geography made him one of the best known geographers of the world.

Honors came rapidly to him for many years. He served one year as president of the Association of American Geographers immediately after his retirement as secretary. He was also president of the National Council of Geography Teachers. His alma mater, as well as Syracuse University and Franklin College, conferred honorary degrees upon him. But the compliment that he prized most was the number of the Annals of the Association of American Geographers that was issued on his seventy-fifth birthday. Here his colleagues and friends paid measured tribute to Brigham—the man, the geologist, the physiographer, the human geographer, the educator and the geographer-envoy from America to Europe. In these several papers, accompanied by a bibliography, is a summary—an appraisement of Brigham's life work to 1930, written with the restraint necessary in writing to the living. Between the lines one can see the affectionate regard and the honor that each writer, speaking for his colleagues, felt for Brigham. This volume was a deserved and yet inadequate tribute that may be summarized in the recent words of one of the younger men who said, "He was a Grand Man in the earth sciences."

His spirit will carry on, and like that of any great teacher or leader, his work will bear results for many generations yet to come. He honored the sciences to which he devoted the major part of his life, and the honors his colleagues naturally bestowed upon him were truly earned.

Richard Elwood Dodge

SCIENTIFIC EVENTS

SYMPOSIA AT THE SYRACUSE MEETING OF THE AMERICAN ASSOCIATION

Program plans for the association's approaching meeting at Syracuse, New York, June 20 to 25, 1932, are rapidly nearing completion. It is expected that the final program will include addresses on subjects of general interest by outstanding scientists in the fields of mathematics, physics, engineering, chemistry, botany, medicine, psychology and education. The association's sections are arranging a scientific session devoted to symposia on timely subjects and also a number of field trips. Program features include the following: Mathematics—invited addresses by four mathematicians of national reputation and a symposium on "The Teaching of Mathematics" (jointly with the Section of Education) with an address by Dr. E. R. Hedrick; Physics—symposium on "The Nature of Light," a joint session with chemists and biologists for a symposium and a general address by Dr. W. F. G. Swann on "Cosmic Rays"; Chemistry—symposium with biologists and physicists on "The Effect of X-rays on Biological Life" and a regional meeting of the American Chemical Society; Geology and Geography—symposia on (1) "Paleozoic Stratigraphy of New York," (2) "Physiography near Syracuse including Glacial Problems," (3) joint session with engineering section on "Aerial Photographic Surveying and Mapping," and conducted geological excursions; Zoology—symposium at joint sessions with chemists and physicists on "The Effect of X-rays on Biological Life" and a series of conducted field trips and a meeting of the Ecological Society of America; Botany—meetings of the Botanical Society of America and other societies and a series of field trips; Anthropology—symposium on Far Eastern Problems; Psychology—symposia on (1) "Industrial Psychology" (jointly with Engineering Section); (2) "Social Statistics" (jointly with Economics, Sociology and Statistics Section); (3) "Mental Hygiene" and a two-day meeting of the Upper New York psychologists; Economics, sociology and statistics—symposia on (1) "Demand and Supply," (2) "Money and Interest" and (3) "Social Statistics," and meetings of the Econometric Society and the American Statistical Association; Engineering—(1) Symposia on "Aerial Photographic Surveying and Mapping," (2) "Industrial Engineering" and (3) "Industrial Psychology" (jointly with the Section of Psychology) and a general address by Dr. J. O. Perrine on "Television"; Medical sciences—several symposia on subjects to be announced later and meetings of the Society for Experimental

Biology and Medicine (Western New York Branch), The American Roentgen Ray Society, the Society of American Bacteriologists (Central New York Branch), Onondaga County Medical Society, and the Syracuse Academy of Medicine; Agriculture—series of symposia on "Land Use" and a symposium on "The Future of the Farmer, Peasant or What?"; a meeting of Northeastern Section of American Society of Agronomy at Geneva and Ithaca; Education—a symposium on (1) "The Teaching of Mathematics" and (2) "Educational Psychology" and a general address by Professor E. L. Thorndike. In addition, several sections of the association will hold sessions for the reading of contributed papers.

CHARLES F. ROOS,
Permanent Secretary

NATURE SANCTUARIES

THE Ecological Society of America has maintained a committee concerned with reservation of natural areas for research purposes since 1917. This committee called a conference on Nature Sanctuaries at New Orleans on December 30, 1931, including the following representatives of societies and government bureaus:

Dr. Francis Ramaley, *chairman*, Ecological Society; Dr. W. R. Chapline, U. S Forest Service; Dr. S. B. Locke, Izaak Walton League; Dr. H. C. Bryant, National Park Service; Dr. Walter P. Taylor, U. S. Biological Survey; Dr. T. Gilbert Pearson, American Ornithological Union; Dr. A. R. Cahn, Ecological Society; Dr. Henry B. Ward, National Parks Association; Mr. Paul L. Errington, Game Survey, conducted for the Sporting Arms and Ammunition Manufacturers Institute; Dr. B. C. Tharp, Ecological Society; Dr. W. S. Cooper, Ecological Society, and Dr. V. E. Shelford, National Research Council.

The representatives at the conference stated the general plans and procedure followed in the reservation by federal agencies of the few existing nature sanctuaries, called "natural areas," "research reserves," etc. They also outlined the ideal plans for nature sanctuaries, conceived in the various organizations representing different biological interests.

After the conference the following report was adopted by the representatives through the mail:

> The participants were agreed that it is desirable and important to set aside, as nature sanctuaries or nature reserves, areas of natural vegetation containing as nearly as possible all the animal species known to have occurred in the areas within historical times.
>
> Nature sanctuaries should be surrounded by very slightly modified areas devoted to experiments, recreation or game culture, etc.
>
> It was the consensus of opinion of those in attendance that these areas should be left alone without management and that only in the case of an emergency that might arise should control measures be undertaken and then only after most careful consideration and determination as to their practical necessity.

V. E. SHELFORD, *Chairman*
Committee for the Study of Plant and Animal Communities, Ecological Society of America

COMMITTEE ON UNEMPLOYMENT AND RELIEF FOR CHEMISTS AND CHEMICAL ENGINEERS

DR. FRANK G. BREYER, executive chairman of the Committee on Unemployment and Relief for Chemists and Chemical Engineers, has addressed to members of the twelve sponsoring societies the following letter:

> More than one hundred members of our profession in the Metropolitan District are in want. Their families are approaching despair. Fifteen hundred more are out of employment. Some have been unemployed for over a year.
>
> Professional fellowship and human sympathy demand that the *more fortunate of us contribute to the* immediate relief of the destitute in our profession. Public relief funds administered by the Gibson and Bliss Committees are running low. They are inadequate to meet the general situation and can no longer be counted upon to take care even of the most desperate cases.
>
> This committee has been organized by the local sections of all the important national chemical and chemical engineering societies. Administrative costs will be paid from funds given specially for this purpose. Your contribution will be applied directly, immediately and sensibly to the relief of chemists and chemical engineers.
>
> We feel the best temporary solution is to finance the work of the Committee on Unemployment and Relief for the period April 25 to July 1. $15,000 is required. An average of $5.00 per month for two months from 1,250 men will give $12,500. We can get $2,500 from other sources. Won't you send by return mail a contribution? Less than $5.00 if you can't afford it. More than $5.00 if you are able. To be followed by an equal sum one month later.
>
> The need is immediate and urgent! Unless we who are more fortunate respond generously many members of our profession face real want, demoralization and tragedy.

Checks should be made payable to R. T. Baldwin, treasurer, and be sent to 300 Madison Avenue, Room 1004, New York City.

AWARD OF THE WILLARD GIBBS MEDAL

DR. EDWARD CURTIS FRANKLIN, professor emeritus of organic chemistry at Stanford University, has been awarded the Willard Gibbs Medal for 1932 by the

Chicago Section of the American Chemical Society. The medal will be presented to Dr. Franklin before a national gathering in Chicago on May 20.

"Dr. Franklin's work on liquid ammonia solutions," the citation reads, "opened up an entirely new field, and also modified profoundly our views on aqueous solutions. He has made a life-long study, characterized by insight, thoroughness and experimental skill, of reactions in liquid ammonia. All trained chemists, both organic and inorganic, are aware of the profound effect of Franklin's work upon modern concepts of the relation between the solvent and the chemistry of the solute. The well-known experimental and theoretical development constituting practically a lifetime contribution has received recognition of the American Chemical Society through the fact that Dr. Franklin was president of our society at one time."

The Gibbs Medal, founded by William A. Converse, was first awarded in 1911 to Svante Arrhenius, of Sweden. It is named for Josiah Willard Gibbs, professor of mathematical physics at Yale from 1871 until 1903, who, although not primarily a chemist, did much to advance the science of physical chemistry.

Previous medallists in addition to Svante Arrhenius include Madame Curie, of France; Sir James C. Irvine, of Scotland, and the following Americans: T. W. Richards, L. H. Baekeland, Ira Remsen, Arthur A. Noyes, Willis R. Whitney, E. W. Morley, W. M. Burton, W. A. Noyes, F. G. Cottrell, Julius Stieglitz, G. N. Lewis, M. Gomberg, J. J. Abel, W. D. Harkins, Claude S. Hudson, Irving Langmuir and Phoebus A. Levene.

Members of this year's jury of award are: B. S. Hopkins, W. Lee Lewis, S. C. Lind, Julius Stieglitz, W. D. Bancroft, G. Borrowman, Otto Folin, F. C. Whitmore, W. L. Evans, J. H. Hildebrand, L. V. Redman and H. Steenbock.

ELECTIONS OF THE NATIONAL ACADEMY OF SCIENCES

At the annual meeting of the National Academy of Sciences held in Washington on April 27, the fifteen new members permitted by the rules were elected as follows: Raymond T. Birge, physicist, University of California; Edwin G. Boring, psychologist, Harvard University; Samuel R. Detwiler, anatomist, Columbia University; Walter A. Jacobs, chemotherapist, Rockefeller Institute for Medical Research; Douglas W. Johnson, geologist, Columbia University; Louis O. Kunkel, plant pathologist, Boyce Thompson Institute, Yonkers, New York; Karl Landsteiner, pathologist, Rockefeller Institute for Medical Research; Walter C. Mendenhall, geologist, U. S. Geological Survey; (Harold) Marston Morse, mathematician, Harvard University; Floyd K. Richtmyer, physicist, Cornell University; John C. Slater, physicist, Massachusetts Institute of Technology; John R. Swanton, anthropologist, Bureau of American Ethnology; Robert J. Trumpler, astronomer, Lick Observatory; Edward W. Washburn, chemist, Bureau of Standards; John B. Whitehead, electrical engineer, the Johns Hopkins University.

Four foreign associates of the academy, who are limited to fifty, were elected. They are: Karl E. von Goebel, botanist, Munich; Fritz Haber, chemist, Berlin; Marchese Marconi, engineer, Italy, and Heinrich Wieland, chemist, Munich.

Arthur Keith, the U. S. Geological Survey, was elected treasurer to succeed President Joseph S. Ames, of the Johns Hopkins University. Professor Ross G. Harrison, Yale University, and Professor Henry Norris Russell, Princeton University, were elected members of the council to succeed Professor Edwin G. Conklin, Princeton University, and Dr. Harlow Shapley, the Harvard Observatory. Officers of the academy, apart from the treasurer, who were elected last year for a four-year term are Dr. W. W. Campbell, University of California and the Lick Observatory, *president;* Dr. David White, U. S. Geological Survey, *vice-president;* Dr. Fred E. Wright, Geophysical Laboratory of the Carnegie Institution, *home secretary;* Dr. R. A. Millikan, the California Institute of Technology, *foreign secretary.* Members of the council continuing in office are: President Karl T. Compton, the Massachusetts Institute of Technology; Dr. W. B. Cannon, Harvard Medical School; Dr. J. McKeen Cattell, New York, and Dr. Roger Adams, University of Illinois.

Dr. W. H. Howell, who retired this year from the directorship of the School of Hygiene and Public Health of the Johns Hopkins University, has been elected chairman of the National Research Council, to succeed Dr. George K. Burgess, director of the Bureau of Standards. A successor to Dr. Vernon Kellogg as permanent secretary of the council has not been elected.

At the dinner of the academy on April 26, the Mary Clark Thompson Medal was presented to Dr. David White, U. S. Geological Survey, the presentation address being made by Professor William B. Scott, of Princeton University. The Public Welfare Medal, awarded a year ago to Dr. Wyckliffe Rose, formerly general director of the International Health Board and president of the General Education Board, who has since died, was received by his son, H. Wyckliffe Rose, the presentation address being made by Dr. Simon Flexner, the Rockefeller Institute for Medical Research.

SCIENTIFIC NOTES AND NEWS

THE death is announced by cable of Dr. Max Rubner, the distinguished physiological chemist of the University of Berlin.

DR. ROBERT A. MILLIKAN, director of the Norman Bridge Laboratory of Physics and chairman of the council of the California Institute of Technology, who has been attending the annual meeting of the National Academy of Sciences of which he is foreign secretary, and Dr. Ray Lyman Wilbur, Secretary of the Interior, with leave of absence from the presidency of Stanford University where he was formerly professor of medicine and dean of the medical school, were the guests of President Hoover at his first week end of this year at the Rapidan camp.

DR. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, has returned to New York on the *Berengaria*, after a 27,000 mile trip on the motorship *Polaris*. He visited on this boat the South Sea Islands, Fiji Islands, Java, Sumatra, Saigon, Siam, Singapore, Ceylon and Cairo.

DR. WERNER HEISENBERG, professor of theoretical physics at Leipzig, will take part in the fifth annual symposium in theoretical physics of the University of Michigan, to be held in connection with the summer session from June 27 to August 19.

EDWARD GOODRICH ACHESON, distinguished for his contributions to electrometallurgy and chemistry, especially in relation to graphite and carborundum, who was elected to membership in the American Philosophical Society on April 22, had died on July 6, 1931, at the age of seventy-five years.

THE German Academy of Sciences in Halle at its recent meeting elected to membership Dr. Joseph Erlanger, professor of physiology in the Washington University (St. Louis) Medical School.

FRANKLIN MEDALS, the highest honor conferred by the Franklin Institute of Philadelphia, have been awarded to Dr. Ambrose Swasey, of Cleveland, builder of telescopes and instruments of precision, and to Dr. Phillip Lenard, director of the radiological institute of the University of Heidelberg. The medals will be presented on May 18, but Dr. Lenard will be unable to attend.

AWARDS have been made by the Royal Geographical Society as follows: The Founder's Medal to Mr. H. G. Watkins, for his work in the Arctic Regions, especially as leader of the British Arctic Air Route Expedition. The Patron's Medal to the Duke of Spoleto, for his work in the Himalaya as leader of the Karakoram Expedition of 1929. The Victoria Medal to Professor A. P. Coleman, of Toronto, for his contributions to the geography and geology of Canada. The Murchison Grant to Dr. K. S. Sandford, secretary of the Commission of the International Geographical Union on Pliocene and Pleistocene terraces, for his personal work in that investigation during the past six years. The Back Grant to Mr. Hugh Clutterbuck, for his expedition to Akpatok Island. The Cuthbert Peek Grant to Miss Gertrude Caton-Thompson, for her investigations in the historical geography of Lake Moeris. The Gill Memorial to Dr. E. B. Worthington, for his studies of East African lakes.

THE *Journal* of the American Medical Association reports that information has been received by the president of the British Ross Award Fund that sufficient funds have been received for the tribute to Sir Ronald Ross, begun last summer. It was planned to raise a fund of a million shillings for Sir Ronald, discoverer of the rôle of the mosquito in the transmission of malaria. About $500 was contributed by American physicians through the Ross Award Fund of America, of which Dr. Robert L. Pitfield, Philadelphia, was secretary.

AT the ceremonies connected with the celebration of the seventy-fifth anniversary of the Chicago Academy of Sciences, the principal address was given on April 11, by Dr. William D. MacMillan, professor of astronomy at the University of Chicago. Officers of the academy have been elected as follows: *President*, Professor Henry C. Cowles, University of Chicago; *Vice-presidents*, Francis R. Dickinson, succeeding Dr. William H. Haas, resigned, and Dr. Edmund Andrews, and *Secretary*, Dr. Nathan S. Davis, III.

DR. T. M. SIMPSON, head of the department of mathematics of the University of Florida, was recently elected president of the Southeastern Section of the Mathematical Association of America.

DR. OLIVER JUSTIN LEE, for the past three years acting director of the Dearborn Observatory of Northwestern University, has been made director.

DR. AUGUSTUS G. POHLMAN, research professor of anatomy at St. Louis University School of Medicine, has been appointed dean of the School of Medicine at the University of South Dakota.

JACOB P. DEN HARTOG, since 1931 chief of the dynamics section of the research laboratory of the Westinghouse Electric and Manufacturing Company, has been appointed assistant professor of applied mechanics at Harvard University.

DR. W. J. MILLER, professor of geology and chairman of the department of the University of California at Los Angeles, delivered the annual faculty research lecture on May 2. The lecture was on "Magmatic Intrusion."

The annual Hermann M. Biggs Memorial Lecture was delivered this year at the Academy of Medicine, New York City, on May 5 by Dr. Lawrason Brown of Saranac Lake. The subject was "Robert Koch and His Life Work."

M. Albert Policard, professor of histology in the University of Lyons, will deliver a Hanna Lecture at the Institute of Pathology of Western Reserve University on May 16, on "The Evolution of Histochemistry."

Dr. Stanhope Bayne-Jones, head of the department of bacteriology at the University of Rochester School of Medicine and Dentistry, gave the address at the annual Sigma Xi initiation dinner of the Rochester Chapter, on April 20. His subject was "Bacterial Variation and Changes in Bacteriology."

Dr. Harlan T. Stetson, director of the Perkins Observatory, Delaware, Ohio, lectured at Syracuse University on Friday evening, April 22, on "The Relation of Sunspots to Radio Reception." The lecture was sponsored by the local chapter of Sigma Xi.

Dr. Joseph Erlanger, professor of physiology at the Washington University (St. Louis) Medical School, delivered a lecture at the University of Michigan on April 26 on "Action Potentials of the Nerve."

Dr. Walter B. Cannon, professor of physiology at the Harvard University Medical School, recently gave the eighth Noble Wiley Jones lectures at the University of Oregon Medical School. The subjects of his addresses were: "The Fluid Matrix as a Means of Stabilizing the Organism," and "The Function of the Autonomic Nervous System in Controlling the Fluid Matrix."

Professor Ludwig Pick, professor of pathologic anatomy at the Friedrichshain Hospital, Berlin, spoke on April 27 on "The So-called Malacic Disorders of Bone" at the annual meeting of the Undergraduate Medical Association of the University of Pennsylvania, under the auspices of the Pathological Society of Philadelphia and the Rush Society of the University of Pennsylvania.

Sir Humphry Rolleston gave the Chadwick public lecture on April 8 in the hall of the Academy of Medicine, Paris, on "The Pioneers and Progress of Preventive Medicine." M. Meillère, president of the academy, presided.

Dr. Maurice C. Hall, chief of the zoological division of the Bureau of Animal Industry, U. S. Department of Agriculture, gave a series of three lectures from March 29 to April 1 at the School of Tropical Medicine, San Juan, Porto Rico. The lectures were as follows: "Principles and Theories of Anthelmintic Medication," "Specific Anthelmintic Medication" and "Parasitology in Its Relation to Other Sciences."

Dr. James W. Jobling, head of the department of pathology of the College of Physicians and Surgeons, Columbia University, attended the annual meeting of the special board of trustees of the School of Tropical Medicine, San Juan, Porto Rico.

The fourth of five awards of funds provided by the Rockefeller Foundation for a year's visit by an American university professor to the Keio Gijuku University of Tokyo, Japan, has been granted to Dr. Winterton C. Curtis, who has for thirty-one years been a member of the faculty of the University of Missouri. As a visiting professor Dr. Curtis will maintain an office in the Keio School of Medicine, in a building erected by the Rockefeller Foundation. He will give instruction in the School of Medicine and in addition will carry on research work.

Dr. Yandell Henderson, professor of applied physiology at Yale University, appeared in Washington on April 19 before a subcommittee of the Committee on Agriculture and Forestry of the Senate, headed by Senator McNary, to speak on a bill which he drew up for Senator Hiram Bingham which is designed to control poisonous substances and preparations which go into households. These substances include benzol, methyl alcohol, formaldehyde, sulphur dioxide, nicotine, etc., and failure to warn consumers of their dangerous properties has led to many fatal accidents. The purpose of the proposed law is to require manufacturers to place a warning label on their products when needed. An even more important object, in Professor Henderson's opinion, is to provide that manufacturers may submit any proposed material to the surgeon-general of the United States for an opinion as to its safety or dangerousness before putting it on the market.

Dr. Charles H. LaWall, dean of the Philadelphia College of Pharmacy and Science, who was appointed some months ago a member of the International Committee of the Health Council of the League of Nations, to study the subject of opium assay methods, and who was at that time appointed a consultant in pharmaceutical chemistry to the U. S. Public Health Service so that he could legally import the opium upon which the experiments were to be made, has completed the first assignment of the work and sent in his reports to the chairman, Professor L. van Itallie, of Leyden, Holland. Other members of the International Committee are Professors H. Baggesgaard Rasmussen, of Copenhagen; R. Eder, of Zurich; A. Goris, of Paris; E. Knaffl-Lenz and I. Wasserberg, of Vienna. There is also a member representing Great Britain and one representing Japan.

The American Association of Cereal Chemists will hold its annual meeting on May 23, 24, 25 and 26, at Detroit, with headquarters at the Statler Hotel.

The fifteenth annual meeting of the American Society of Ichthyologists and Herpetologists is being held in Washington from May 5 to 7. Sessions are held at the U. S. National Museum. The local committee consists of Dr. William M. Mann, director of the National Zoological Park; Miss Doris Cochran, of the U. S. National Museum, and Mr. M. K. Brady, of Washington. The annual dinner of the society will be held on Friday evening, May 6. On Saturday there will be a luncheon at the National Zoological Park, in association with the American Society of Mammalogists, followed by a tour of the park in the afternoon.

The scientific session of the American Heart Association will be held on Tuesday, May 10, from 9:30 A. M. to 5:30 P. M. in the New Orleans Municipal Auditorium, New Orleans.

A Pacific intersectional meeting of the American Chemical Society, including the local sections of Arizona, California, Idaho, Montana, Nevada, Oregon, Utah and Washington, will be held at the State College of Washington, Pullman, Washington, on June 15 to 18, in connection with the meeting of the Pacific Division of the American Association for the Advancement of Science. Dr. J. L. St. John, of the division of chemistry, Agricultural Experiment Station, Pullman, Washington, is chairman of the program committee. Titles of papers for presentation at this meeting should be in his hands before May 1, 1932.

The annual meeting of the Canadian Medical Association will be held in Toronto from June 20 to 24, under the presidency of Professor Alexander Primrose, who has lately retired from the faculty of the University of Toronto.

The Kentucky Academy of Science held its nineteenth annual meeting at the Eastern Kentucky State Teachers College, Richmond, on April 23. Officers elected were: *President*, Professor George Roberts, University of Kentucky; *Vice-president*, Dr. Robert T. Hinton, Georgetown College; *Secretary*, A. M. Peter, and *Treasurer*, W. S. Anderson, both of the University of Kentucky. *Representative in the Council of the American Association for the Advancement of Science*, Dr. A. R. Middleton, University of Louisville; *member of the Publications Committee*, Dr. J. B. Miner, University of Kentucky. Dr. Irvin Abell, of the University of Louisville, and Dr. Charles E. Spearman, of the University of London, delivered addresses at the general session.

At a meeting of the College of Medicine of the University of Illinois Chapter of Sigma Xi, held on March 30, four members were promoted from associate to active membership, eleven elected to active membership, and twenty-two elected to associate membership. The scientific program consisted of the presentation of the following research work: "The Effect of Heat Sterilization on the Activity of Dried Pollen Extract," Dr. B. Z. Rappaport; "Studies on the Discharge of Bile in the Duodenum," Dr. C. B. Puestow, and "Alterations in Renal Response Following Denervation," Dr. G. Milles. Dr. A. A. Zimmermann, who was the delegate from the chapter, made a report on the national convention, held at New Orleans. The chapter voted that it be suggested to the National Executive Committee that the annual convention in 1933 be held in Chicago.

A meeting of the Society of Chemical Industry will be held jointly with the American Chemical Society, the Electrochemical Society and the Société de Chimie Industrielle on May 13 at 8:30 P. M., at the Chemists' Club, 52 East 41st St., New York. Dinner preceding the meeting will be served at 7:00 o'clock. The program will be devoted to the presentation of a paper by Mr. Edgar C. Bain, of the United States Steel Corporation, on "Some Fundamental Characteristics of Stainless Steels."

The Tenth Annual Colloid Symposium will be held at Ottawa, Canada, on June 16, 17 and 18. Dr. Emil Hatschek, of London, will be the guest of honor. He will give a paper on "The Study of Gels by Physical Methods" before the symposium and will deliver a public address on "Jellies" the evening of the first day of the meeting.

The directors of the Alexander Dallas Bache Fund of the National Academy of Sciences, Drs. W. J. V. Osterhout, E. B. Wilson and Heber D. Curtis, *chairman*, made grants in aid of research as follows at the April meeting of the Academy: To Dr. Matilda Brooks, University of California, for collecting Valonia specimens and shipping from Tortugas to Woods Hole; to Frank A. Perret, vulcanologist, Martinique, F. W. I., to assist in building and equipping a volcano laboratory on the slope of Mt. Pelée; to Dr. Robert Hegner, of the Johns Hopkins University, for further research at Panama on the parasites of monkeys; to Dr. N. Bobrovnikoff, Perkins Observatory, for the preparation of a general catalogue of comets, with emphasis upon astrophysical data; to Director Frank C. Jordan, Allegheny Observatory, for the determination of stellar parallaxes from Allegheny plates; to Dr. Charles Kofoid, of the University of California, to continue work done under an earlier grant on the ciliated protozoa of ruminants.

AN Associated Press dispatch reports that a cargo of unusual and valuable foreign plant species gathered on an 8,000-mile cruise of the Caribbean Sea has been brought to the United States aboard the yacht of Mr. Allison V. Armour, of New York. Rare palms, new vegetables and species for experiment to develop the production of the Southeast were included in the cargo. The owner of the yacht, *The Utowana,* was accompanied by Dr. David Fairchild, Mr. P. H. Dorsett and Mr. W. F. Loomis, of the staff of the division of cotton and rubber plant investigations of the U. S. Department of Agriculture, and Mr. L. R. Toy, of the new homestead branch experiment station at Florida.

DISCUSSION

WHAT IS A PUBLICATION?

FOR many years systematists in the botanical and zoological fields have debated, often with considerable acrimony, the subject of what constitutes publication. I wish, as indicated in the title, to direct attention to a slightly different aspect of the problem, namely, to the methods of reproducing manuscript. Prior to the present century an easy and sharp distinction could be made between manuscripts and documents reproduced by use of cast type. There were few or no intermediate processes. But during the past two decades with perfection of appropriate machines a rapidly increasing amount of extensively duplicated material has been issued in typewriter face. Duplicate copies produced by direct manual effort on a typewriter are obviously still to be considered as manuscript. The gelatin-pad processes (hectograph, "ditto," *et cetera*) need not be considered, since the number of copies so produced is limited. It is the printing of typewriter reproduction by forcing ink through a stencil (mimeograph) and the printing of typewriter facsimile by use of roller or ribbon-applied inks (multigraph) which need consideration.

Dr. C. W. Stiles, in his scholarly address to the American Ornithologists' Union in 1927 on "What constitutes publication?"[1] set up the following theoretical definition for a zoological publication: "The manifolding of a dated zoological document which is intended as permanent record and which is made potentially and reasonably available to the populus zoologicus as of the decade of issue" (p. 477). He also touched upon the "methods of manifolding manuscript" and indicated several means of reproduction, including the stencil (mimeograph). But he concluded his brief discussion of this subject by saying "in view of the economic problems involved, I am not prepared to take a definite stand on the question of technique of manifolding manuscript as a condition precedent to recognizing publication" (p. 475).

However, it seems to me that some definite decision must be made with respect to mimeographed and multigraphed materials, particularly those items which agree in other respects with the accepted requirements for publication.

In order to provide a basis for discussion, some of the materials which fall into this controversial field will be described. These items are used merely as examples to illustrate the problem; no reflection is intended on organizations or persons concerned, because of their use of the methods herein discussed.

The U. S. Bureau of Biological Survey has issued a mimeographed series of "Bird Banding Notes," of which 17 numbers appeared between 1922 and 1925. A footnote on the first page of each issue stated that "'Bird Banding Notes' is not a publication and is not for general distribution. It is issued for the information of cooperators of the Biological Survey, but anyone using in a published paper any of the information contained in it will be expected to give credit to the person named and to the Bureau."

In March, 1926, the Biological Survey issued a special report on "Our migratory wild fowl and present conditions affecting their abundance," by E. W. Nelson. This bore a designation "BSR-1 Special Report," as though it were the initial item in a series. The cover is printed in a non-typewriter face; the text is in typewriter face on both sides of the sheet, printed so clearly as to suggest it may have been the product of the movable types of a multigraph machine. In the published history of "The Bureau of Biological Survey"[2] by Jenks Cameron this item is not included in the formal list of publications but is mentioned on p. 219 together with a mimeographed report on effect of rodent poisons on game birds; a footnote says of the latter, "this was published in July, 1927; the wildfowl report in March, 1926."

The Pacific Northwest Bird and Mammal Society [Club to 1922] has since 1920 issued thrice a year, in January, May and September, "The Murrelet," which is stated to be the "official bulletin" of the society. Any person interested in birds or mammals may become a member of the organization upon payment of dues and may purchase back numbers of "The Murrelet." At first entirely mimeographed, a printed cover of regular form was added with the issue of January, 1925. Beginning in January, 1930 (Vol. xi, No. 1) text as well as cover is printed. The general form of the earlier mimeographed issues of "The Murrelet" differs in no respect from that of a periodical printed on a letterpress, save for the limitation in type face. "The Murrelet" includes material similar in nature to that appearing in many letterpress journals, such as notes on the distribution, habits and ecology of birds and mammals in northwestern North America. Each issue includes a table of contents, and two 5-year indices have been issued. A sample entry is entitled "Farthest North Record of Fur Seal," by J. F. Bernard ("Murrelet," vi, No. 1, January, 1925, p. 14); it reports the occurrence of a large male fur seal at Sledge Island, near Nome, Alaska, on September 15, 1924. This record is exactly similar to many occurring in printed journals, such as the *Journal of Mammalogy*. "The Murrelet" is included in the "Union List of Serials in Libraries of the United States and Canada," issued by the H. W. Wilson Company, of New York, and sets are reported in ten libraries. Items in "The Murrelet" submitted by members of the U. S. Bureau of Biological Survey are included with other "Articles in Current Publications by Department Workers" in the weekly Official Record of the U. S. Department of Agriculture.

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[1] SCIENCE, n. s., 67: 471–478, 1928.

[2] Institute for Government Research, Service Monographs of the U. S. Government, No. 54, 1929.

Some years ago Dr. Royal N. Chapman prepared an outline of his course in insect ecology, as given at the University of Minnesota. The "publication," as it is called in the preface, is of 8½ x 11 inch size, consisting of ix + 1–187 + 1–183 pages with table of contents, bibliography and text figures, and is mimeographed. A printed title page bears the legend: Animal Ecology/ with especial reference to/ insects/—/by/ Royal N. Chapman/ The University of Minnesota/—/All rights reserved/—/Burgess-Brooke, Inc./ publishers/ Minneapolis, Minn,/ 1925. [Preface dated June 1926.] The volume is bound with a pressboard cover. It was for sale at a stated price and so reasonably available to the zoological public. Under date of April 22, 1927, Burgess-Roseberry Company (formerly Burgess-Brooke, Inc.) who describe themselves as "mimeograph publishers," announced a second mimeographed edition of this work, to be of 370 pages. Material from these two editions of the mimeographed volume have frequently been cited in current ecological literature, and this "title" has been included in terminal bibliographies. In 1931 a volume from the pen of Dr. Chapman under the same title was issued by a commercial publisher in conventional book form. This is a third edition, much revised.

Were all mimeographed and multigraphed productions similar in form to those already mentioned, little difficulty would be involved concerning their status, but grading downward, there is every conceivable intermediate form until the circular letter is reached! Of intermediate status are the "house organs" and "news bulletins" such as those put out by the Bureau of Biological Survey ("The Survey"), by the California State Department of Agriculture and by the naturalists of several of our western National Parks. Of the latter, the one emanating from Yosemite National Park was first mimeographed and later began appearing in printed form; others from the General Grant and Yellowstone parks are still in mimeographed form. These latter contain original material, often of considerable record value, and are available to a wide public.

The greater convenience and lessened cost of these newer means for duplicating and disseminating information in "periodical" or "book" form have been of increasing importance in this country in the last decade, and there is no reason to suppose that their use will decrease in the future. Many of the documents so produced, from their beginnings, contain original material of sound scientific worth. Their intrinsic value as records of scientific work is indicated by repeated citation in other scientific literature. They have been generally accepted by the large majority of scientific writers as conventional documents equivalent to those printed by movable types and letterpress. Admittedly there may be difficulty in making a distinction between casual announcements, press releases, news bulletins and "house organs" intended for a circulation restricted to the personnel of a particular organization, on the one hand, and, on the other, items such as those specifically described above of either periodical or separate character, which are distributed free or by sale to the interested public, and of which some eventuate in conventionally printed form.

The degree of permanency of a document has not been considered to be a criterion in determining what constitutes publication, since many documents both old and recent, of thoroughly accepted status, have been upon the flimsiest of paper and of a sort to be preserved only with difficulty.

The question, then, of what constitutes a publication seems not to be concerned solely with the mechanism of reproduction, but rather with the character of the document. Difficult and uncertain as will be the problem of segregating out true publications, according to Dr. Stile's theoretical definition quoted above, it seems inevitable that items answering the requirements of that definition, even though they be printed by movable types of typewriter face or by stencils, can not be excluded from the category of publications.

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THE PATHOGENICITY OF NEISSERIA SICCA

Neisseria sicca is a small gram-negative, aerobic diplococcus. Its growth on agar consists of irregularly round, raised, opaque, slightly yellowish colonies which may reach a diameter of 3 mm. The colonies are dull, dry, with a deeply furrowed surface and a crenated edge. Attempts to remove these colonies show them to be very firm and some of them adherent to the surface of the medium. The removed colony is found to be difficult to disintegrate, and impossible to emulsify. When grown in a liquid medium the organism agglutinates spontaneously. Most of the writers on the subject state that acid, but no gas, is produced from dextrose, maltose, levulose and saccharose. The action on saccharose was delayed in the organism which I studied. Besides the rough type of colony described above, a smooth type has been noticed. Variants of a smooth type were observed in my cultures.

As to the specificity of *N. sicca* and other members of the genus Neisseria found in the nasopharynx, Wilson[1] states:

> It seems probable that the gram-negative cocci of the nasopharynx form a single species within which are a few more or less constant subspecies, each of which is itself subject to variation. Until we know more of the extent of this variation it does not seem justifiable to assign names to the numerous types that have from time to time been described by different investigators.

But this is a controversial point.

Under the title, "Acute vegetative endocarditis with multiple secondary foci of involvement due to M. Pharynitides siccae," Schultz[2] described a case of clinical endocarditis from the blood of which a pure culture of a gram-negative diplococcus was grown. This organism was not agglutinated by polyvalant antimeningococcus serum. Acid, but no gas, was produced from dextrose, saccharose and maltose; there was no reaction in mannite or litmus milk.

Kretschmer and Hufnagel[3] isolated a similar organism from the pus of a kidney at operation.

Recently, I identified *N. sicca* from the blood stream of a boy, 12 years of age, who had been ill with clinical endocarditis for two weeks. He complained of headache; a petechial rash extended over the abdomen, and valvular disease of the heart was present. *N. sicca* was isolated on three occasions from the blood stream. Several cultures made of the spinal fluid proved negative.

Detection of the growth of *N. sicca* in the blood culture made in liquid medium may be readily overlooked, due to the adherence of the organisms to each other, and to its not forming a diffused growth.

Neisseria sicca appears to be a pathogen and more of a clinical entity than we have suspected.

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CHROMOSOME NUMBERS IN ALTHEA ROSEA

Because of its economic importance, cotton has been the subject of much cytological investigation. Denham, in 1924, compared the chromosome numbers of the New World and Egyptian cottons with those of the Asiatic varieties. He reports the haploid number of the former as 26 and that of the latter as 13. The chromosome numbers of the other genera of the family have not been reported so far as known.

Flower buds of *Althea rosea* were collected during the summer of 1931 and fixed in various solutions. Chromosomes were counted in both homeotypic and heterotypic divisions and it appears that the haploid number of the species is 13.

Further study of the different genera is planned together with a more detailed cytological work.

George W. Burkett
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ON "ACADEMIC FREEDOM IN SPAIN"

In Science for April 15, Father P. H. Yancey, S.J., suggests a boycott by American educators as a protest against the "brutal attack" on academic freedom perpetrated by the Spanish government in forbidding members of the Jesuit order to teach in Spain, and confiscating their property. Such a statement by an educator and a member of that order deserves notice, since I am unable to understand how academic freedom is directly involved in the issue.

An inclination to comment on this matter is due to my having been born and reared in Spain. I received my education there, graduating from the University of Madrid. I have known rather intimately the conditions which led to the fall of the monarchy, and I have been in touch with the situation in Spain since leaving that country.

The suppression of the Jesuits with the advent of a new order was a foregone conclusion in the minds of both liberal Catholics and dissenters. Certainly, the teaching activities of the members of this order have not been the cause of objection, nor their personal beliefs, which they have been free to express wherever and whenever they chose. The Society of Jesus has been forbidden to carry on its appointed tasks in Spain because its members take, in addition to three vows which are not objectionable, a fourth vow of absolute submission to a power residing outside the state. The Spanish people through their elected representatives insist on the sovereignty of the state over its subjects, regardless of the form of government, which may be modified by popular will. This attitude, recently emphasized by the arrest and deportation of communist agitators holding membership in the Third Internationale, is in sharp contrast with the complacency of the monarchy, which allowed in its midst groups of nationals engaged in social and political activities while bound by oath to obey a foreign power.

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[1] Wilson, *J. Path. and Bact.*, 31, 477, 1928.

[2] Schultz, *J. A. M. A.*, 71, 1739, 1918.

[3] Kretschmer and Hufnagel, *J. A. M. A.*, 82, 1850, 1924.

The measures taken by the Spanish government against the Jesuits, although they may incidentally have encroached upon their academic freedom, are, therefore, primarily a national move for self-preservation. In a way they are less severe than they might appear, for it must be remembered that the members of the order were actually expelled from Spain in 1767, not by a republican government, however, but by His Most Catholic Majesty Charles III. The Society of Jesus was expelled from France in 1594, restored in 1603, again expelled in 1764, and for the last time in 1880. Its members have also been expelled at various times from other Catholic communities, and the order suppressed in 1773 by Pope Clement XIV, but it was revived in 1814.

One may question the wisdom of such harsh measures, but in so far as they are aimed not at individuals but at groups or corporations whose activities may ultimately be inimical to the sovereignty of the state, they do not fall under the category of attacks on academic freedom as it is generally understood.

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REPORTS

RECENT WORK ON AMERICAN INDIAN LANGUAGES

FOR a long time students of the American Indians have felt the need of more intensive work on American linguistics. After the attempts of Dr. Albert Gallatin to give a summary of distribution of American languages in the *Transactions* of the American Ethnological Society, the problem was taken up anew by Daniel G. Brinton, who worked particularly on the manuscripts accumulated in the University of Pennsylvania and published the Library of Aboriginal American Literature; and by J. G. Shea in his "Library of American Linguistics," Volumes 1 to 13. The Bureau of American Ethnology collected the data for Powell's Linguistic Map of North America and continued from time to time the publication of text material in various Indian languages. A more systematic attempt at a presentation of the fundamental structures of American Indian languages was not made until in Bulletin 40 of the Bureau of American Ethnology a series of grammatical sketches of American Indian languages were presented. In the time between 1911–1922 the following sketches of language were published in this bulletin:

Athapaskan, by Pliny E. Goddard
Tlingit, by John R. Swanton
Haida, by John R. Swanton
Tsimshian, by Franz Boas
Kwakiutl, by Franz Boas
Chinook, by Franz Boas
Maidu, by Roland B. Dixon
Algonquian, by William Jones and Truman Michelson
Dakota, by Franz Boas and John R. Swanton
Takelma, by Edward Sapir
Coos, by Leo J. Frachtenberg
Siuslawan, by Leo J. Frachtenberg
Chukchee, by Waldemar Bogoras

During the same period the collections of texts in American languages increased considerably. The American Ethnological Society published a series of thirteen volumes; and Columbia University, the University of California, the American Museum of Natural History, the Bureau of American Ethnology, the University of Washington, Seattle, and the Geological Survey of Canada also published considerable text series.

Work on American languages was taken up more systematically and energetically when the American Council of Learned Societies included this work in its program and interested the Carnegie Corporation in it. The American Council of Learned Societies was able to give considerable financial support to this undertaking through appropriations made for the purpose by the Carnegie Corporation. A Committee on Research in Native American Languages was appointed consisting of Franz Boas, *chairman,* Leonard Bloomfield and Edward Sapir to carry on the work with the help of a general committee consisting of M. J. Andrade, J. de Angulo, Father Berard, R. B. Dixon, J. P. Harrington, M. Jacobs, D. Jenness, A. V. Kidder, A. L. Kroeber, T. Michelson, F. M. Olbrechts, G. A. Reichard, F. G. Speck and J. R. Swanton. Since the period for which the committee was first established has reached its end it seems appropriate to make a general statement in regard to the field work accomplished and the material published.

The following is a summary report of the Committee covering the period from 1927 to 1931. Some of these investigations have been carried on in cooperation with other agencies.

It has been the endeavor of the committee to fill in the most important gaps in our knowledge of American languages. This required field investigations on languages which are on the verge of extinction, revision of older, inadequately reported languages, and attempts at dialectic studies with a view of laying a basis to historical studies of the development of various groups. The last named problem is so large that it was impossible to undertake it in a systematic way.

The selection of fields of work was also necessarily determined by the interests and training of the available investigators.

Work on vanishing languages was done particularly in Oklahoma and on the Pacific Coast. Under this item may be enumerated:

Kitsai and Wichita, by Dr. Alexander Lesser
Tonkawa, by Dr. Harry Hoijer
Yuchi, by Dr. Günter Wagner
Catawba, by Dr. Frank G. Speck
Mohican, by Miss Olive Eggan
Tillamook, by Miss May Mandelbaum
Nootsak, by Dr. Thelma Adamson
Kalapuya, Molala, and Cayuse, by Dr. Melville Jacobs

A number of Pacific Coast languages, although not exactly on the verge of extinction, nevertheless belong to this group. I mention under this head:

Quileute, by Dr. Manuel J. Andrade
Yokuts, by Mr. Stanley S. Newman
Patwin and Wappo, by Dr. Paul Radin
Wishram and Washo, by Mr. Walter Dyk
Atsugewi, Achumawi, Shasta, Karok, by Dr. Jaime de Angulo
Karok, by Mr. John P. Harrington
Pomo, by Dr. Jaime de Angulo
Zuni, by Dr. Ruth L. Bunzel
Yuki, by Dr. Alfred L. Kroeber
Maidu and phonetics of northern California languages, by Mr. Hans J. Uldall

Material on linguistic groups was collected as follows:

Athapaskan
Chippewyan, Hare, by Dr. Fang-Kuei Li
Wailaki, Mattole, by Dr. Fang-Kuei Li
Wailaki, by Dr. Pliny E. Goddard
Lipan, Mescalero, by Dr. Harry Hoijer

Here should be mentioned Professor Sapir's continued study of Athapaskan dialects and his own and Father Berard's studies of Navaho.

Siouan
Dakota, by Miss Ella C. Deloria
Winnebago, by Dr. John Broderius
Crow, by Dr. Robert H. Lowie
(Catawba, by Dr. Frank G. Speck, mentioned before)

Salish
Coeur d'Alêne, by Dr. Gladys A. Reichard
Thompson, by Miss Elizabeth Dijour
Cowlitz, by Dr. Thelma Adamson
Chehalis, by Dr. Franz Boas
Moses Columbia, by Miss Velpha Walters
(Nootsak and Tillamook, mentioned before)

Caddoan
Pawnee, by Dr. Gene Weltfish
(Kitsai and Wichita, mentioned before)

Sahaptin
Klickitat, by Dr. Melville Jacobs
Sahaptin, by Mr. Verne Ray
Nez Percé, by Mr. Archie Phinney

Wakashan
Nitinat, by Mr. Morris Swadesh
Kwakiutl, by Dr. Franz Boas
Bella Bella, by Dr. Franz Boas

Muskokian
Creek, by Mr. Vic Riste
Natchez, by Mr. Vic Riste

Iroquois
Cherokee, by Dr. Frans M. Olbrechts
Iroquois, by Dr. Frans M. Olbrechts

Miscellaneous
Pame (or Chichimeco, Mexico), by Dr. Jaime de Angulo
Zapotec, by Dr. Paul Radin
Otomi, by Dr. Paul Radin
Tlappanec, by Dr. Paul Radin
Kechua, by Miss Elizabeth Dijour
Pipil, by Prof. Leonhard Schultze-Jena
Cora, by Prof. Theodor Preuss
Aleut Text and Grammar, by Mr. Waldemar Jochelson

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Sahaptin Texts. Melville Jacobs. Publications, University of Washington, Vol. ii, No. 6, pp. 175–244.

Bella Bella Texts. Franz Boas. Columbia University Contributions to Anthropology, Vol. v, pp. viii, 291.

Religion of the Kwakiutl. Franz Boas. Columbia University Contributions to Anthropology, Vol. x, Pt. 1, pp. xviii, 284; Pt. 2, pp. viii, 288.

Crow Texts. Robert H. Lowie. Publications of the University of California, Vol. 29, No. 2.

Karuk Texts. John P. Harrington. *International Journal of American Linguistics*, Vol. vi, No. 2, pp. 121–161.

Karok Texts. Jaime de Angulo. *International Journal of American Linguistics*, Vol. vi, Nos. 3–4, pp. 194–226.

Two Cherokee Texts. Frans M. Olbrechts. *International Journal of American Linguistics*, Vol. vi, Nos. 3–4, pp. 179–184.

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Zuñi Ritual Poetry. Ruth L. Bunzel. Bureau of American Ethnology. In press.

GRAMMARS PUBLISHED

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Mattole. Fang-Kuei Li. Publications, University of Chicago, pp. 1–152.

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Achumawi Language. Jaime de Angulo. *International Journal of American Linguistics*, Vol. vi, No. 2, pp. 77–120.

A Study of Sarcee Verb-Stems. Fang-Kuei Li. *International Journal of American Linguistics*, Vol. vi, No. 1, p. 3–27.

Relationship of Mixe to the Penutian Family. Lucy S. Freeland. *International Journal of American Linguistics*, Vol. vi, No. 1, pp. 28–35.

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Notes on Dakota Language. Franz Boas and Ella Deloria. *International Journal of American Linguistics*, Vol. vii. In press.

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Cherokee Texts. Frans M. Olbrechts. Bureau of American Ethnology. In press.

READY FOR PUBLICATION

Zapotec Texts with Translation. Paul Radin.
Chippewyan Stems and Grammar. Fang-Kuei Li.
Tonkawa Grammar. Harry Hoijer.
Wishram Verb Stems. Walter Dyk.
Grammatical Notes on Tlappanec. Paul Radin.

MATERIAL BEING WORKED UP

Yokuts Comparative Grammar. Stanley Newman
Wishram Grammar. Walter Dyk.
Quileute Grammar. Manuel J. Andrade.
Yuchi Grammar. Günter Wagner.
Catawba Texts. Frank G. Speck.
Tillamook Texts and Grammar. May Mandelbaum.
Sahaptin Texts. Melville Jacobs.
Aleut Grammar. Waldemar Jochelson.
Zuñi Grammar. Ruth L. Bunzel.
Wailaki Grammar and Texts. Fang-Kuei Li.
Chippewyan Texts. Fang-Kuei Li.
Hare Grammar and Texts. Fang-Kuei Li.
Tonkawa Texts and Dictionary. Harry Hoijer.
Apache Grammar and Texts. Harry Hoijer.
Wishram Dictionary. Walter Dyk.
Washo Grammar and Texts. Walter Dyk.
Creek Grammar and Texts. Vic Riste.
Natchez Material. Vic Riste.
Notes on Mohican. Olive Eggan.
Winnebago Grammar and Texts. John Broderius.
Nitinat Grammar and Texts. Morris Swadesh.
Thompson Grammar and Texts. Elizabeth Dijour.
Patwin. Paul Radin.
Kitsai Grammar and Texts. Alexander Lesser.
Nez Percé Texts. Archie Phinney.
Teton Grammar, Dictionary and Texts. Ella Deloria.
Cayuse Vocabulary. Melville Jacobs.
Crow Grammar and Texts. Robert H. Lowie
Pawnee. Gene Weltfish.
Maidu, and Northern California Phonetics. Hans J. Uldall.
Pomo. Jaime de Angulo.
Yuki. Alfred L. Kroeber.
Zuñi Texts. Ruth L. Bunzel.
Cherokee and Iroquois. Frans M. Olbrechts.
Pipil. Leonhard Schultze-Jena.
Aleut Texts. Waldemar Jochelson.
Siberian Eskimo Grammar. Waldemar Bogoras.

While a considerable amount of work has been accomplished, much remains to be done to preserve the vanishing languages which will be required for later studies, and to record those languages which occupy key position in the various stocks. The exigencies of the situation make it quite impossible to carry through systematic investigations of those linguistic stocks that have developed the greatest number of markedly distinct dialects, although we may hope to learn from this material most in regard to the history of American languages. On the other hand, there are so many languages the linguistic position of which is still entirely doubtful that it was necessary to pay attention rather to these than to others. It has long been recognized that studies of this kind should be extended over Latin-America. If the work of the committee, as it is hoped, will be continued beyond the present year, the problem of extending the work over the vanishing languages of Latin-America ought to be kept in mind.

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SCIENCE SERVICE CONFERENCE[1]

ARE the social sciences really sciences? Can economics and the other studies that bear immediately and intimately on human affairs be handled with the same detached objectivity that is possible to a physicist or to a biologist? This question became the subject of a brief friendly debate between a noted physicist and an equally noted economist at the dinner following a conference called by Science Service to discuss possible improvements in the transmission to the public of scientific news and information.

The question was first raised during the afternoon conference by Robert P. Scripps, editorial director of the Scripps-Howard Newspapers, whose father, the late E. W. Scripps, was the founder of Science Service. The ruling idea in his father's mind when he launched the enterprise, Mr. Scripps said, was to benefit humanity by the wider dissemination of scientific knowledge and method; and he suggested, as in line with this tradition, the possible advisability of adding the so-called social sciences to the scope of Science Service's work.

In his evening address, Professor Robert A. Millikan, director of the Norman Bridge Laboratory of the California Institute of Technology, expressed frank doubts as to whether the social sciences are really scientific. The thing that really characterizes a science, he said, is the existence of a large body of facts, a universally accepted doctrine. A science such as physics, he pointed out, is based on such a body of facts, and though this basis may be added to, the later additions work no essential change in the earlier known truths. There is, of course, always a margin of disagreement, usually over new developments, but as compared with the main body of the science this is very narrow indeed.

In economics and the other social sciences, Dr. Millikan held, an exactly opposite condition obtains. The body of agreed-on doctrine is vanishingly small, and the field in which experts disagree comprises almost the whole of the science. Furthermore, the disagreement extends beyond questions of fact into the lightning-charged field of the emotions and human passions, so that the conflicts arising therein are much more intense than they are in the more academic realm of the physical sciences. For this reason, the speaker concluded, it would seem inadvisable, perhaps dangerous, for an organization like Science Service to undertake an extension of its activities into the social science field at the present time.

Dr. H. G. Moulton, president of the Brookings Institution, Washington, D. C., spoke as an active champion of the social sciences, both as having an intimate and potentially useful bearing on human life and as being susceptible to a really scientific approach. Economics was once as definite a science as physics, he said, at least so far as having a definite basis of agreed-on doctrine is concerned. It has only been during the past one or two generations that this apparently solid basis has been dissolved by the revolutionary changes brought about by recent world events. The facts of economics and the other social sciences are still there, he insisted, and still capable of the impartial and objective treatment demanded by true scientific method. He felt that they constitute a challenge to an institution for the popular dissemination of knowledge, like Science Service, and that work in this field would be a quite proper undertaking.

The remaining discussion during the evening session was given an entirely different turn by Dr. John H. Finley, editor of the *New York Times*. He spoke of the problem from an editor's angle, stressing the constant necessity of working with speed yet with accuracy, of maintaining a balance of material selected, of watchfulness against propaganda from any source, and of the editor's need to "know a little about everything, and to know where to turn to find out everything about anything."

Dr. William H. Welch, dean of the medical faculty of the Johns Hopkins University, presided at the evening meeting.

During the afternoon session, a succession of five-minute talks by various eminent scientists and representatives of the press set forth a symposium of views on the more immediate problems involved in getting correct information on scientific advances and scientific methods before the general public. The conference was held in the building of the National Academy of Sciences, immediately after the close of the spring meeting of the Academy, and a majority of the scientists present were members of that organization, often called "the Senate of American Science."

In opening the discussion, Dr. J. McKeen Cattell, editor of SCIENCE and president of Science Service, paid a tribute to the late E. W. Scripps and to Dr. William E. Ritter, of the University of California, as co-founders of Science Service. "If Scripps was the Charlemagne who could do all this with a high hand, Ritter was the Alcuin who advised him." Attention was also called to the part taken in the founding of the service by Drs. George E. Hale, Robert A. Millikan, A. A. Noyes and Vernon Kellogg and the invaluable work of the first director, Dr. Edwin E. Slosson.

Then, in rapid succession, the scientists and newspaper men voiced their opinions and suggestions.

Dr. Simon Flexner, director of laboratories of the Rockefeller Institute for Medical Research, New York

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[1] Reported by Science Service.

City, spoke of the need for more than ordinary precaution in handling medical news, and suggested the advisability of submitting all items to an advisor well qualified in medical science before publication.

Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, expressed the wish that scientific institutions and organizations might "feed in" important and desirable news items, so that they may receive prompt and adequate public notice.

Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, spoke on the necessity of informing people not only on new scientific discoveries but on scientific method and outlook as well. The rulers of the world are uninformed of the natural forces that control the world, he said, and much of the present crop of disastrous legislature is such simply because it runs counter to natural laws. If it is to be avoided and wise laws passed, the lawmakers must be given the information they need.

A. H. Kirchhofer, editor of the Buffalo Evening News, spoke as a representative of the press. He asked for more mutual tolerance and patience between scientists and newspapermen, and expressed the belief that news stories on scientific subjects would be more satisfactory both to editors and to scientists if the latter would give intelligent reporters their cooperation.

Dr. John C. Merriam, president of the Carnegie Institution of Washington, after warning newspapermen against trying to make "good copy" and big headlines out of researches still in the discussion stage, concluded with the suggestion that the knowledge of interest by the public in such unfinished problems may stimulate scientists to express their findings more clearly and understandably when they finally reach them.

Dr. A. A. Noyes, director of the Gates Chemical Laboratory of the California Institute of Technology, made two suggestions: first, the desirability of making clear the evidential status of any announcement put forth as a news item; second, the possibility of using younger scientists in the various laboratories and universities as local correspondents.

Professor E. B. Wilson, of Harvard University, called attention to the differing aspects of the concept of accuracy, depending on the audience to whom a given scientific discovery or fact is to be presented. Details that are absolutely essential before a group of scientists may only befog the picture if they are used before a lay audience, and thus destroy instead of make for accuracy in the image that gets into the minds destined to receive it.

Dr. Charles G. Abbot, secretary of the Smithsonian Institution, registered strong approval of a new Science Service enterprise, the distribution of low-priced phonograph records giving brief talks by leading scientists, and expressed the hope that further issues of this sort would be made.

Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, Philadelphia, voiced his faith in the ability of "the man in the street" to understand science if it is properly presented to him. "I would much rather talk about relativity to an intelligent lawyer or an intelligent clergyman than to a bad physicist," he said.

Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington, in Boston, stressed the desirability of care and accuracy in reporting medical discoveries, because of the great immediate importance of these to human life, and the possible lamentable consequences of even apparently minor error.

Dr. Paul R. Heyl, of the U. S. Bureau of Standards, suggested that general summaries or reviews of progress in science might be well received, and would be useful to scientists as well as to the lay public.

Professor A. E. Kennelly, of Harvard University, called attention to possible errors of impression that readers might receive if undue emphasis is placed on the wrong point in reporting a scientific discovery or event. He also made a plea for the expression of quantitative results in the metric system, which he termed "the international language of science."

Professor Charles R. Stockard, of Cornell Medical College, reinforced previously expressed pleas for a high degree of accuracy in reporting medical news. He further suggested the desirability of explaining properly how animal experimentation is used in working out medical advances, as a counter to anti-vivisection propaganda.

Professor Joel H. Hildebrand, of the University of California, expressed his desire that science articles intended for the general public give not merely the news of discoveries but that they also stress the importance of the scientific method in thinking and working.

Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography, La Jolla, California, declared that his relations with the press had always been satisfactory, because he was willing to meet intelligent newspapermen half way. He recommended cooperation to his fellow-scientists.

Professor Richard M. Field, Princeton University geologist, called attention to the natural interest of the public in the economic aspects of science, and in economic questions generally.

Dr. F. P. Keppel, president of the Carnegie Corporation, commended Science Service for having "stuck to its last," and said he hoped it would continue to do so.

Dr. F. G. Cottrell, chemist and inventor of the precipitation process, laid fresh emphasis on the necessity of presenting science as news to newspapers.

Capt. J. F. Hellweg, of the U. S. Navy, spoke briefly on "what should not be printed."

Professor Knight Dunlap, of the Johns Hopkins University, contrasted conditions in science news reporting since Science Service entered the field with what they were before that time, and expressed the hope that this organization would continue its work independently, not only for the work it is doing itself but for its stimulating effect on the science reporting of the other newspaper syndicates.

Dr. W. H. Howell, of the Johns Hopkins Medical School, chairman of the executive committee of Science Service, closed the discussion with an expression of thanks to his fellow-scientists for their cooperation in the work of Science Service.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CRITIQUE OF THE SERIAL DILUTION METHOD FOR QUANTITATIVE DETERMINATION OF BACTERIOPHAGE

The two current methods for quantitative determination of bacteriophage are the plaque count and the serial dilution technique. The latter procedure involves testing successive dilutions of the lytic principle for ability to produce visible lysis of a broth culture of susceptible bacteria. The final effective dilution is assumed to contain at least one phage particle and the titre of the original lysate is calculated upon this basis.

For the plaque count, phage dilutions are plated upon a substrate of susceptible organisms. The resulting punched-out, bare areas in the surface growth are considered to represent the loci of single phage particles. Their number, together with the dilution factor, should theoretically furnish a simple means of estimating the total phage/ml. in the sample.

That agreement between the two methods above outlined is far from satisfactory for quantitative work is apparent from a survey of the literature. Further, the use of either procedure alone does not permit of accurate comparative determinations. In the case of the plaque count it has been pointed out by Bronfenbrenner [1, 2] that there are several factors not amenable to ready control which effect the formation of plaques; consequently, checks are difficult to procure.

The serial dilution technic presents similar limitations. Clark[3] has analyzed the method upon purely statistical grounds and concludes that with a dilution factor of 0.1 only 60 per cent. of parallel runs on the same solution should give an identical end-point. It is shown in the present paper that some of the difficulties encountered in practical application of the method are explicable on the basis of the kinetics of the bacterium-bacteriophage reaction.

The chief points established regarding the mechanism of phage action, as exemplified by susceptible Staphylococci growing in the presence of anti-Staphylococcus phage, may be briefly summarized as follows:

(1) Phage formation is conditioned by bacterial growth.[4]

(2) The percentage rate of increase in phage is proportional to the percentage rate of increase of bacteria, *i.e.*,

$$\frac{dP}{Pdt} = C\frac{dB}{Bdt.}$$

(3) Phage accumulates within the bacteria, meanwhile maintaining equilibrium with phage in the broth outside the cells, until a certain concentration of phage per bacterium is attained, when lysis ensues. There is thus a definite lytic threshold.[4, 5]

(4) Phage is distributed between susceptible cells and the fluid medium in two ways depending upon whether the bacteria are alive or dead. With live cells (resting or growing) distribution is of normal type and diffusion of phage, into or out of the organisms, proceeds according to a definite quantitative relationship. If the cells are dead, however, they adsorb phage irreversibly and equilibrium may be represented in terms of the Freundlich adsorption isotherm equation.[6]

The purpose of the serial dilution procedure is to ascertain the highest effective phage dilution capable of initiating visible lysis in the test suspension and consequently the technique has been assumed to rest upon a qualitative test for the presence of phage. However, in the case of the organism and phage studied, the qualitative test is conditioned by definite quantitative factors and in effect does not determine whether phage is present or absent in the higher dilutions but rather whether or not a certain minimum quantity of phage is present. This amount is not constant but varies with test conditions.

Consideration of two cases will clarify the above statement. Keeping in mind the dependence of lysis upon development of a certain high intracellular con-

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[1] J. Bronfenbrenner and C. Korb, *J. Exp. Med.*, 42, 483, 1925.

[2] J. Bronfenbrenner and C. Korb, *Proc. Soc. Exp. Biol. and Med.*, 21, 315, 1924.

[3] H. Clark, *J. Gen. Physiol.*, 11, 71, 1927.

[4] A. P. Krueger and J. H. Northrop, *J. Gen. Physiol.*, 14 (No. 2), 223, 1930.

[5] J. H. Northrop and A. P. Krueger, *J. Gen. Physiol.*, (in press).

[6] A. P. Krueger, *J. Gen. Physiol.*, 14 (No. 4), 493, 1931.

centration of phage per bacterium, it follows that with a large initial concentration of phage ($[P]_0$), the initial concentration of bacteria ($[B]_0$) may be varied within rather wide limits and lysis will still occur. That is, relatively few cell divisions will result in the production of enough phage to raise the phage-bacterial ratio to the lytic level. This has been demonstrated experimentally.[4]

On the other hand, if $[P]_0$ is small as must obtain in the last few tubes of the serial dilution set-up, it is clear that the magnitude of $[B]_0$ will considerably influence the outcome. A certain minimal number of cell divisions will be required to raise [P] to the effective threshold for lysis and if $[B]_0$ is too large the organisms will enter the maximal growth stationary phase before such a condition is realized. For a given small $[P]_0$ there thus exists a maximal $[B]_0$ beyond which lysis can not be expected to occur. Again, experimental confirmation is direct. With $[P]_0$ small and constant in a series of tubes, successively larger $[B]_0$'s are added under conditions described in previous work.[4] Cellular dissolution results in all the lower members of the series up to a certain point beyond which the suspensions do not clear.

That phage may have been present in the uncleared tubes can be demonstrated by filtering these suspensions and again seeding them with identical $[B]_0$'s. Frequently two or three of the second series will lyse, indicating that phage was originally present but in such small amounts that the lytic threshold was unattainable. However, bacterial reproduction resulted in an appreciable increase in [P] (proven by direct titration) and the second passage upon susceptible organisms developed a concentration adequate for lytic action.

Since development of the lytic end-point depends upon the initial concentration of bacteria used in seeding the test series, the serial dilution technique as usually carried out presents a potential source of error. The customary assumption that the final effective dilution contains one phage particle and the unlysed tubes no such particles is substantially in error and it should be recognized that the titration data can not be expressed accurately in terms of actual lytic particles. Most work does not necessitate absolute enumeration. Nevertheless, in order to make even comparative quantitative determinations of phage, $[B]_0$ should be carefully controlled.

At least one other factor significantly influences the test; namely, the percentage of dead bacteria present in the suspension. Dead cells adsorb phage quickly, irreversibly and in relatively large amounts under ordinary test conditions.[6] Hence their presence will delay, and may readily prevent altogether, the development in live cells of the critical lytic P : B ratio. Dead cells can not be entirely excluded, but it is rational to limit their numbers to a small and rather constant percentage of total cells by employing young cultures of the same age.

The writer has described a method for comparative quantitative phage determinations possessing none of the objections to which the plaque count and serial dilution technique are open.[7, 8] The procedure is based upon a relationship between $[P]_0$ and the time of lysis predicted by kinetic analysis of the bacterium-bacteriophage reaction.[4] Experience with over 200 routine titrations has demonstrated that [P] can be determined with an accuracy of ± 3 per cent.

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A SIMPLE METHOD OF REARING AND MOUNTING HOOKWORM[1] LARVAE

In an effort to partially meet the demands for suitable and adequate laboratory materials for students in biology, the writers have developed a simple method of rearing and mounting hookworm larvae. While the procedure is in part a modification of older methods the technique is very simple, requiring little or no special equipment, and is thus an improvement over the older methods. It is possible by this method to supply large numbers of students with living and mounted specimens of this important human parasite with a minimum amount of trouble to the instructor. This is especially true in the Southern states, where hookworm reservoirs are relatively easy to locate.

Rearing

The usual method of mixing infected feces with powdered charcoal in the proportions of approximately two parts of charcoal to one part of feces was used in rearing larvae. Both animal and plant charcoal were used with equally good results. Suitable containers, such as flat-bottomed watch glasses, were filled with the charcoal mixture and placed in larger shallow pans containing water about one fourth of an inch deep. Each pan was then covered with a plate of glass and the material was incubated at room temperature until the larvae reached the desired stage.

Two general methods of isolating larvae were used. In the first method the material remained undisturbed for a week or ten days until many of the infective larvae had migrated from the fecal material into the surrounding water. The water was then strained through several layers of cheese-cloth into a specially arranged funnel, and the lower contents of the fun-

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[7] A. P. Krueger, *J. Gen. Physiol.*, 13, 557, 1930.

[8] A. P. Krueger, Science, lxxii, 1872, 507, 1930.

[1] *Necator americanus.*

nel drained off after a period of 6 to 10 hours. The second was a modification of Baerman's[2] method to permit the isolation of larvae at any stage of their development. In this procedure a heavy wire was bent into a circle of such diameter as to fit into a large funnel and rest on the sides about two inches from the top. Four layers of cheese-cloth were stretched over the wire ring with the edges of the cloth raised so as to form a crude flat bottomed bag. The watch glasses containing the fecal material were inverted on the bottom of the bag; it was then fitted into the funnel which contained enough water to cover the watch glasses. The funnel was equipped with rubber tubing and a stopcock at the lower end and was mounted on a suitable stand. This arrangement of the funnel was the same as that referred to in the first method of isolation.

The larvae that collected over night in the stem of the funnel were drawn off through the stopcock into vials about one inch in diameter and two or more inches deep. The larvae rapidly settled to the bottom and could be obtained in large numbers for classroom study or for mounting. The writers, using a single drop of material, have observed more than forty individuals in the same field of a 100-magnification compound microscope.

Vials of living larvae were kept in the laboratory for about three weeks; they could be kept for longer periods. It was necessary, however, to pipette most of the water off and replace it with fresh water daily to prevent the larvae from dying.

MOUNTING

In preparing larvae for mounting, alcohol was used as a killing and hardening agent. Most of the water was drawn out of the vial and the vial filled with 5 per cent. alcohol. After standing fifteen minutes, the 5 per cent. alcohol was replaced with 70 per cent. alcohol. The larvae were hardened within two hours and remained in this solution, in good condition, for more than two weeks.

The larvae were mounted by transferring a drop of material from the bottom of the vial to a slide. The alcohol on the slide was immediately ignited and allowed to burn off, thereby affixing the larvae. The mount was then placed under a pair of binoculars and any large pieces of débris were removed with a needle, after which the larvae were covered with Delafield's Haematoxylin. After staining 10 to 15 minutes, the excess haematoxylin was flushed off with water running slowly from the tap; only a few seconds were required for the washing. The slide was again placed under the binoculars to see that the desired depth of color had been obtained, and was allowed to dry thoroughly. The larvae were then mounted under balsam in the usual manner.

Congo red, Orange G and alum cochineal were also used successfully as stains, but the larval structures were more distinct when haematoxylin was used.

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SPECIAL ARTICLES

STIMULATIVE EFFECTS OF ILLUMINATING GAS ON TREES

IN an investigation to determine significant symptoms of illuminating gas poisoning of shade trees a series of stimulation phenomena have been observed and recorded during February and March, 1932. The general features of these responses will be described briefly at this time since they may have application during the early spring in the detection of shade trees undergoing the incipient stages of illuminating gas injury.

In the investigation so far, no attempt has been made to determine how small an amount of illuminating gas will give responses in the plant material used. Entire potted trees, tree buds, tree roots, cuttings of shrubs and tree seeds have been subjected to complete atmospheres of illuminating gas and to atmospheres containing 10 per cent. to 40 per cent. of this gas by volume. The commercial product of the New Haven Gas Light Company was used throughout. This gas is a mixture of coke-oven gas and water gas.

When small potted dormant black oak, red oak and catalpa trees were subjected in a closed ash can to an atmosphere containing approximately 20 per cent. of illuminating gas for 24 and 48 hours, respectively, and then placed in a greenhouse, the buds of the gassed trees began to swell and the leaves to unfold weeks before similar control trees showed any bud activity. The exact gain in time cannot be stated as yet because the control trees at this time (a period of 4 weeks) are still dormant.

When test-tubes filled with illuminating gas were sealed over the dormant terminal buds of potted red and black oak trees for one and two days, respectively, active bud development and foliage production was observed weeks in advance of these responses in control trees. The buds of the control trees were encased in test-tubes in an atmosphere of air. Buds encased for 4 and 8 days, respectively, in illuminating gas were inhibited in their development or killed.

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[2] G. Baerman, ''Über Ankylostomiasis deren Ausbreitungsbedingungen durch die Bodeninfection und deren Bekaempfung.'' Geneeskundig Tijdschrift voor Nederlandsch-Indie, 57, 579–673, 1917.

When the roots of dormant, potted red and black oak trees were washed free of soil and sealed in an atmosphere of illuminating gas with the stems and buds exposed to greenhouse air, the buds were hastened into active growth 3 to 4 weeks before those of control trees whose roots were sealed in an atmosphere of air. The roots of the gassed oak trees developed a large number of hypertrophied lenticels. Ailanthus trees treated in a similar manner did not show hypertrophied lenticels; the tap-roots of these trees split wide open due to the proliferation of parenchymatous cells. Information upon the behavior of the roots of American elm, Norway maple, sycamore, catalpa, white pine, red pine and bald cypress in atmospheres of illuminating gas has also been obtained.

When the soil-free roots of foliaged red and black oak trees were subjected to a sealed atmosphere of illuminating gas for one day and then repotted in soil, a slight wilting of the leaves occurred, followed by complete recovery. However, when the roots were so exposed for 2, 3, and 7 days, respectively, marked epinastic growth of the oak leaf petioles occurred and wilting of the tips and margins of the leaves took place. Within a few days, drying of the wilted tissue was observed together with a complete loss of leaf pigments proceeding from the distal ends of the leaves to the basal ends.

When dormant cuttings of Forsythia and lilac were enclosed in an atmosphere of illuminating gas for periods of 15 minutes up to 4 days, the shorter exposures hastened flower and leaf bud development and opening. The longer exposures inhibited or killed the terminal buds. In several experiments, gassed Forsythia cuttings developed few or no flowers but the leaf buds developed first and produced apparently normal leaves. At this time, a month after the exposures of the cuttings of Forsythia and lilac to gas, the cuttings exposed the longest periods are developing leaves from the lower buds and callus development is proceeding at the bases of the cuttings. The control cuttings have shriveled and died.

When dormant acorns of red, scarlet and black oaks were subjected to an atmosphere of illuminating gas for periods of 6 hours up to 4 days, respectively, a slight slowing of the rate of germination of the red oak acorns gassed the longest periods was observed. The black oak acorns, apparently the most dormant of the group, were distinctly hastened in their rate of germination by the longest exposures to illuminating gas.

The investigation is being continued with the object of determining the constituent or constituents of illuminating gas that may be responsible for the several plant stimulation responses recorded. Particular attention will be given to a study of the effects of known mixtures of oxygen, carbon dioxide and ethylene upon trees.

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OBSERVATIONS ON TASTE BLINDNESS

It has been noted by Fox[1] that individuals vary to a remarkable degree with regard to their capacity to taste para-ethoxy-phenyl-thio-urea, 40 per cent. of the individuals he examined failing to find the substance bitter. These observations have been confirmed by Blakeslee[2] and Snyder.[3]

The latter two authors found that this difference in reaction to taste is inherited and that, genetically, taste deficiency is due to a single recessive gene (Snyder). In an examination of 100 families Snyder finds nine in which both parents and all the 17 children failed to perceive the bitter taste, and Blakeslee reports three matings with eight children, all of whom were non-tasters. The suggestion is also made that the test may be used in cases of disputed paternity in the same way as the blood groups (Blakeslee).

The findings quoted led to an investigation on possible racial differences as regards taste blindness. We have examined the incidence of tasters and non-tasters among American Indians at the Haskel Institute in Lawrence, Kansas. One hundred and eighty-three full-blooded Indians were tested, and of these 6 per cent. were non-tasters. Among 110 Indians with some white admixture there were 14, or 10.4 per cent., non-tasters. The incidence of non-tasters among the white population (150 individuals) in Lawrence, Kansas, was 42 per cent. The latter figure is to be compared with 32.2 per cent. non-tasters among 283 white individuals (Blakeslee), and 31.5 per cent. non-tasters among 440 white individuals (Snyder).

These results indicate another property in addition to the Landsteiner blood groups and the factors M and N which differ considerably in frequency in the American Indians, as compared to that of the white population.[4, 5, 6, 7]

[1] A. L. Fox, *Science*, 73, supplement, p. 14, April 17, 1931.

[2] A. F. Blakeslee and M. R. Salmon, *Eugenical News*, 16, 105, 1931.

[3] L. H. Snyder, *Science*, 74, 151, 1931.

[4] A. F. Coca and O. Deibert, *Jour. Immunol.*, 8, 478, 1923.

[5] L. H. Snyder, *Am. Journ. Phys. Anthropol.*, 9, 233, 1926.

[6] C. Nigg, *Jour. Immunol.*, 11, 319, 1926.

[7] K. Landsteiner and Ph. Levine, *Jour. Immunol.*, 16, 123, 1929.

In addition it may be of interest to put on record the results of tests in two among a number of families[8] examined in which the results vary from those already published.

In one family both parents found the substance tasteless in each of three different tests, the father stating on two of these occasions that the substance was not at all bitter but only very slightly sour. Of the six children tested, five found the substance to be very bitter, the sixth child reporting the substance to be tasteless. On a retest of two of the children (one of whom was a non-taster), the results were confirmed.

In the second family the father found the substance to be very slightly bitter, remarking that he hardly would have noticed the taste. The mother found the substance tasteless. Of the six children tested, four children, the two oldest and two youngest, reported the substance to be tasteless, while two children, nine and seven years, respectively, found it to be bitter, in one case very bitter.

The parents and the children in each of the two families seemed to be quite intelligent and their responses to the test were definite. In neither of the two families was any suspicion of illegitimacy, either from the history or from blood tests.

It may be worth while mentioning that in his study Blakeslee found individuals who did not perceive a bitter taste but noticed a taste of another sort.

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LAWRENCE, KANSAS

THE DISTRIBUTION OF CAECAL SPIROCHETES

FOLLOWING the studies made on spirochetes in chickens,[1] further observations have been made on the distribution and morphology of these organisms. The caeca from recently killed ducks, turkeys, guinea-hens, geese, squabs, lambs, calves and pigs were obtained and studied. Examinations of caecal contents and scrapings of caecal walls mounted in Ringer's solution were made by means of dark-field illumination. Films of caecal scrapings were stained by the potassium permanganate-gentian violet method of staining spirochetes.[2] All specimens of duck caeca examined showed the presence of spirochetes—long active treponemas, also small delicate treponemas, spironemas and the fusi-spirochaeta types. In several specimens, still warm, these showed extreme activity and indications of transverse division. In turkeys the various forms of spirochetes were also present in all caeca examined. The same was also true of guinea-hens. The specimens of caecal scrapings from geese was markedly different, showing only an occasional spirochete, and many specimens showed none. Squabs showed no spirochetes in the intestinal tract at any point, and caeca were absent. The fresh warm caeca from lambs and calves were negative for spirochetes. In the caeca from pigs there was a variation, but in general spirochetes were only occasionally present in the specimens obtained.

The organisms observed in ducks, turkeys and guinea-hens appeared morphologically like those previously reported in the chickens—the treponemas being up to 0.5 micron in width and varying to about 7 microns in length. The organisms have closely wound spirals, pointed ends, and exhibit great activity. The spironema type is more loosely coiled, 0.75 to 1 micron in width and up to 10 microns in length, has pointed ends, is flexible, but does not possess the great activity of the treponemas. The fusi-spirochaeta forms previously described in chickens were also observed in all specimens containing spirochetes. The specimens of turkey and guinea-hen caeca showed the latter forms in especially large numbers and in a highly active state.

For a morphological study of spirochetes, such as is at present in progress, there is no difficulty whatever in obtaining suitable material, since these organisms may be obtained from a variety of birds. According to our present knowledge, they appear to be non-pathogenic. Although a detailed report on morphological observations is not completed, it might be mentioned that specimens of warm caecal scrapings mounted on a slide (in Ringer's), with a vaseline-sealed coverslip, and kept in a constant temperature chamber at 36° to 38° C., will still show forms of spirochetes, somewhat active after two months, in addition to the granular and other forms commonly observed.[3]

MINNIE B. HARRIS

THE JOHNS HOPKINS UNIVERSITY

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BRAY, WILLIAM C. and WENDELL M. LATIMER. *A Course in General Chemistry.* Pp. x + 159. Macmillan. $1.60.

CREED, R. S. and others. *Reflex Activity of the Spinal Cord.* Pp. vi + 183. 71 figures. Oxford University Press. $3.25.

SCOTT, WILLIAM B. *An Introduction to Geology.* Vol. I: *Physical Geology.* Pp. xiii + 604. 264 figures. $3.50. Vol. II: *Historical Geology.* Pp. vii + 485. 124 figures. $3.00. Macmillan.

THOMSON, SIR J. ARTHUR. *Purpose in Evolution.* Pp. 55. Oxford University Press. $.75.

TORREY, RAY E. *General Botany for Colleges.* Pp. xxii + 449. 252 figures. Century. $3.50.

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[8] For some of these families we are indebted to Dr. A. S. Wiener.

[1] *Amer. Jour. Hyg.*, Vol. xii, 3, 537–568, November, 1930.

[2] SCIENCE, Vol. lxii, 1863, 275, September 12, 1930.

[3] These studies were begun under a National Research Council Fellowship in Medicine.

SCIENCE

Vol. 75 Friday, May 13, 1932 No. 1950

The Fad as a Factor in Botanical Publication: Dr. Neil E. Stevens 499

Obituary:

Wickliffe Rose: Dr. Simon Flexner. *Memorials; Recent Deaths* 504

Scientific Events:

The York Meeting of the British Association; Western Reserve Chapter of Sigma Xi; State Academies of Science; Geological Sessions at the Summer Meeting of the American Association 507

Scientific Notes and News 509

Discussion:

Misnamed Cultures and Studies of the Tubercle Bacillus: Professor E. G. Hastings and Janet McCarter. *Reading Knowledge:* L. G. Romell. *Recent Find of Mammoth Remains in the Quaternary of Florida, together with Arrow-head:* Jack H. Connery 513

Scientific Apparatus and Laboratory Methods:

A Method for the Disarticulation of Skull Bones: I. A. Wiles. *Discarded Roentgen Ray Film for the Mounting of Museum Specimens:* Dr. Harold D. Caylor. *A Note on the Determination of Iron in Blood and Biological Fluids:* Adolph Bernhard and I. J. Drekter 516

Special Articles:

The Inactivation of Mosaic Disease Virus by Pulverizing Infected Tissue: Dr. Peter K. Olitsky and Dr. Filip C. Forsbeck. *The Etiology of Poliomyelitis:* Dr. Frederick Eberson. *The Relationship between the Water Content and Oxygen Consumption of the Organism:* W. R. Duryee 518

Science News 10

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THE FAD AS A FACTOR IN BOTANICAL PUBLICATION[1]

By Dr. NEIL E. STEVENS

BUREAU OF PLANT INDUSTRY

If, as Pope and many others have asserted, "the proper study of mankind is man," botanists may occasionally study botanists and no apology is needed for asking this botanical society to direct its attention to one of the manifestations of botanical psychology. It is obvious that all we know about plants comes to us through the medium of the botanical mind, and in studying the botanical publications of any period, it is important to know what botanists were thinking about at that time. For, much as we may dislike the idea, we must admit that the conclusions which investigators draw from their observations, perhaps even the observations themselves, or at least the kind of observations they are most likely to make and to publish, are influenced by what others are observing, publishing and talking about.

In the work of the Plant Disease Survey we deal constantly with observations made by others, and in an attempt to study the relative incidence of disease at different periods it becomes of first importance to discover what particular diseases were in fashion and thus most likely to be noticed at any given time. It was, then, this practical necessity which led me to spend a good deal of time during the past year in reviewing American botanical literature. Some of the incidental results of this study I wish to discuss tonight. To avoid wearying you beyond endurance I have confined the statistical portion of this paper to the last 50 years, 1881 to 1930, and to the following representative American publications: *Bulletin of the*

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[1] Address of the retiring president of the Botanical Society of Washington, D. C.

Torrey Botanical Club, Botanical Gazette, Phytopathology, American Journal of Botany and the botanical material contained in the scientific publications of the U. S. Department of Agriculture, including the *Journal of Agricultural Research* and the *Contributions of the U. S. National Herbarium* in so far as these represent the work of the members of the Department of Agriculture.

I am aware of course of the immense volume of American botanical matter outside of this list and of the still greater volume outside of the United States, but the material chosen is merely illustrative, and I must bear in mind the necessity of having enough people left at the conclusion of this paper to elect officers.

The curve[2] which gives the total pages of botanical matter exclusive of reviews and abstracts in these publications indicates an increase so great as to eliminate any question of observational error. From a paltry 259 pages in 1881, we attained in 1929 an all-time American high of 5,284. To be sure, the botanical output, like the stock market, broke sharply in 1930, and the curve of increase seems to lose some of the steepness after 1918 or 1919. Nevertheless, this output, especially when viewed against a background of other special journals, experiment station publications and foreign literature in many languages, presents an aspect which is little less than appalling.

Of what does this mass of botanical print consist? Its composition varies from year to year as a little study or even reflection will speedily reveal.

SPACE DEVOTED TO VARIOUS LINES OF BOTANY IN THE AMERICAN PUBLICATIONS LISTED IN THE TEXT

Year	Total pages	Approximate per cent. of total pages given to				
		Systematic botany	Morphology	Physiology	Ecology	Pathology
1881	259	85				
1890	640	61	5	2		24
1900	1,925	34	9	5	1	33
1910	3,342	33	8	6	6	11
1920	4,437	9	11	18	6	29
1930	3,841	10	13	26	1	41

Taking 1881 and the succeeding decimal years as examples we find that of the 259 pages published in 1881, 85 per cent. was systematic botany, including work on local floras. In 1890, of a total of 640 pages, systematic botany made up 61 per cent., pathology 24 per cent., all about diseases due to fungi, morphology 5 per cent. and physiology 2 per cent. In 1900 there was a total of 1,925 pages, of which systematic botany occupied only 34 per cent., morphology and physiology 9 and 5 per cent., respectively, while there was 1 per cent. of ecology and 33 per cent. pathology. The figure for ecology is unusually low and that of pathology unusually high, as 1900 seems to have been an exceedingly favorable year for pathology. Ten years later, out of a total of approximately 3,300 pages, 33 per cent. was systematic botany and 8 per cent. morphology, about 6 per cent. each physiology and ecology and 11 per cent. pathology. In 1920, of a grand total of 4,437 pages, systematic botany made up less than 10 per cent., morphology 11 per cent., physiology 18 per cent., ecology 6 per cent. and pathology 29 per cent., two thirds of which was about fungus diseases. Last year, out of a total of 3,841 pages, systematic botany had about 10 per cent., morphology 13 per cent., physiology 26 per cent., and pathology showed 41 per cent. The apparent slump in ecology is largely due, no doubt, to the establishment of an independent journal for papers in this branch of botany and zoology.

What causes these differences? Why, for example, do systematic papers make up only about 10 per cent. of the total botanical material which appears in these standard journals? I realize, of course, that many good systematic papers appear outside these series and that the decline is in part relative, but no one will contend that systematic botany occupies anything like the position it did fifty or even thirty years ago. No one will maintain either that the necessity for systematic work is past. Nor am I convinced that brains capable of serious taxonomic studies are no longer produced in America. I have heard various reasons advanced to account for this obvious decline, among others, that the systematists have made themselves ridiculous by describing numerous scarcely distinguishable "species" by endless changing of names and bickering about nomenclatorial rules. It has also been argued seriously by competent botanists that taxonomic work has been rendered more or less futile by the concept of evolution and that systematic botany depends for its existence on a belief in the fixity of species. However much weight these considerations may have, it seems to be the fact that taxonomy is out of fashion just as truly, if not quite so completely, as snuff.

The question just raised may fairly be reversed and injury made as to why morphology, physiology and pathology did not occupy larger places in American botany in 1881. From a much longer list I will cite a number of discoveries or lines of work published between 1859 and 1869 well within the range of facilities then available in the United States and sufficiently striking to have deflected a substantial fraction of botanical interest but for the existence of strong inhibiting influences.

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[2] The paper was illustrated by a series of charts showing the volume of publication on various phases of botany during the period 1881 to 1930. The general trend of these curves is indicated in the text with sufficient detail to be easily followed by any one familiar with American botanical literature.

1859	The "Origin of Species," from which the study of structural adaptations, mechanisms of pollination, distribution of seeds, and related problems received a great impetus in Europe.
1861	Pasteur's discovery that yeast and several species of bacteria were able to live in the absence of oxygen.
1863	Max Schulze's demonstration of the identity of protoplasm of plants and the so-called "sarcode" of the animal physiologists.
1863	Work of Sanio on the process of secondary thickening of the axis of the Dicotyledons and Conifers.
1864	De Bary's demonstration of the heteroecism of the stem rust of wheat.
1860–5	Sachs' work on photosynthesis and especially the application of the iodine test for starch.
1865	Darwin's study of climbing plants.
1866	Sachs' great work, "Experimental-physiologie der Pflanzen," was published. Yet plant physiology did not get fairly under way in the United States until about 1890.
1867	Hildebrandt as a result of crossing yellow and a dark brown race of maize noticed xenia, although he did not call it by that name.
1868	The first edition of Sachs' "Lehrbuch."
1868	Williamson's first memoir on the coal measures.
1869	Darwin's work on heterostylism.

To the question as to why physiology was not more vigorously pursued in the United States fifty or sixty years ago, one is tempted to repeat that it was out of fashion at that time. Possibly the Victorian botanical mind recoiled instinctively from the study of the life processes and sexuality of plants. Speaking more seriously, the influences which kept American botany in the face of all this distraction almost exclusively on the single track of the taxonomy of flowering plants must have been profound. First of all, of course, was the exploration urge. We were then at the period when the finding of new things in the field took precedence over all other activities, but together with this, emphasizing it and, I believe, extending the period, was the influence of Asa Gray, who, for a period of over thirty years, dominated American botany more completely than any one botanist is likely to again. So complete was this domination that even the systematic study of the lower forms of plant life was almost crowded out of the picture.

The story of the change from this condition, which you may designate as the emancipation from the fetters of the herbarium or, if you prefer, the degeneration of American botanical science, is perhaps more easily traced in the graphs showing pages of publication. And this may be a good time to emphasize again that I am not discussing facts but conceptions, not value of publications but volume of publications.

Physiology, morphology and pathology are all represented, although, of course, very scantily in the first year included in this review. The first to expand markedly was pathology. The flood of papers on plant pathology, especially on diseases due to fungi, followed closely on the perfection by Koch of the plate method of isolating bacteria and fungi, and the discovery by Millardet in France, of the effectiveness of copper and lime as an agent in the control of downy mildew of the grape. Whether we have passed the crest of the curve of production of print on fungus diseases is, of course, problematical. But no doubt some of our colleagues would warmly welcome such a change and there are some indications of its approach. It may be a sign of the times that whereas we used some years ago to hear from mycologists much of the importance of mycology to phytopathology, the summer of 1930 found them insisting at Cambridge that mycology was entitled to consideration in its own right wholly independent of plant pathology.

The story of the rise of physiology, morphology and cytology in the United States is largely the story of the importation, belated importation, perhaps, and the development here of botanical conceptions and methods already under way in Europe. In 1888 or 1889, both physiology and morphology entered on a period of expansion which became more marked nine or ten years later. Ecology claimed a place in the American sun in the year 1899, three years after the publication of Warming's great work. The "Sem Bot" of the University of Nebraska was engaged in a study which would have led to ecology before 1892, but the cumbersome term they employed, "phytogeography," stood no chance against the shorter term, "ecology."

However, I am less concerned now with these large waves of interest than with the smaller wavelets which may fairly be designated as fads. I might point out, for example, that in the control of plant diseases we have passed through, during the last fifty years, a Bordeaux period, a lime sulfur period, a dusting period, and are now in an eradication and quarantine period. Of course Bordeaux and lime sulfur are still used, but they are no longer talked about. Our most recent pathological fad is obviously that on virus diseases, which was launched by the work of Allard, 1913 and 1914, and reached what may be a crest in 1926.

Nor are other branches of plant science free from the influence of fads. Among American morphological publications during the period under discussion, two conspicuous fads may be mentioned. The embryo sac fad which began about 1894 or 1895 and continued to show considerable activity through 1916, but is now apparently practically over, and the chromosome fad, which got fairly under way in 1897 and 1898, following Strasburger's great generalization regarding the different numbers of chromosomes in the two generations of a plant, slumped to almost nothing in 1916–17–18, and is now enjoying a second run of popularity due apparently to the discovery that there is a connection between the number of chromosomes and the possibility of producing fertile hybrids in certain genera.

In recent physiological papers the most noticeable fads, at least to the outside observer, are the study of hydrogen-ion concentration and the study of light relations. This last started by the publications of Garner and Allard on the relation between duration of daily illumination and reproduction of certain plants.

Are these Waves of Interest Fads?

Webster defines fad as a "hobby, whim, custom or amusement followed for a time with exaggerated zeal."

The International Dictionary elaborates this somewhat and defines a fad as "a trivial fancy adopted and pursued for a time with irrational zeal; a matter of no importance, or an important matter imperfectly understood, taken up and urged with more zeal than sense." I leave you to judge of the correctness of the term, but I can find no better English word.

What Starts a Fad?

In the first place it seems to me, that in order for a real fad to start the stage must be set. Apparently there is no great chance of a fad taking hold close on the heels of another one. It must wait until the collective botanic mind, or rather a portion of the botanic mind, has reached a condition approaching saturation. Note, for example, that the virus disease fad came to the relief of the phytopathologists, as fungus disease publication was approaching 900 pages a year and that ecology came into the United States when taxonomic work was getting close to 1,000 pages a year. Ecology seemed to offer a man with systematic instincts a chance to do a little systematic work without being too critical about the literature and synonomy, and to do some local flora work under a new and attractive name.

Given a favorable stage setting, the fad seems to be started by some discovery, paper or suggestion which is sufficiently different from the common run of good botanical matter to attract attention, but not sufficiently different to prevent its being readily understood. I may say, here, that I find the name of but one man connected with the inception of more than one fad. This is, of course, our fellow Washington botanist, H. A. Allard. I am credibly informed also that Allard is responsible for starting fads in the study of the synchronization of the stridulation of certain insects and the flashing of fireflies. Needless to say, I await with interest what this original mind will start next.

The Next Fad

I will not even venture to predict what the next fad will be. If I knew I should get out a paper on the subject immediately. A year ago I felt that we were well on our way to a fad for the study of peat bogs by the method of pollen analysis. But this, perhaps because it savors of fossil botany, seems to be thriving better in Europe than America.

Some Potential Fads that Failed to Materialize

It is, of course, perfectly possible for an outstanding, even a striking, achievement which attracts a good deal of attention to fail to produce a fad. I have never understood why Blakeslee's discovery of sexuality in the mucors did not start a fad. "Physiologically balanced solutions" and "antagonism," which were words to conjure with in 1906 and 1908, seem not to have caught the botanical imagination as did "length of day." "Carbo-hydrate-nitrogen-ratio" apparently started no such fad as did "hydrogen-ion concentration." One might reasonably have expected the outstanding success of Dr. Coville in developing the native blueberry and thus creating a new industry in the "barrens" of New Jersey to have aroused great interest in our uncultivated native fruits, but there seems to have been no great increase in such interest.

There are apparently certain lines of botanical investigation which have never taken very vigorous root in American soil. Notable among these is, of course, paleobotany, which, in spite of a few very distinguished workers and a wealth of available material, has never assumed a large place in American botanical work.

What Stops a Fad?

The real answer to the question of why fads stop is that they do not, they merely cease to be fads, that is, each of them leaves some more or less permanent imprint or, to change the figure, influences the course of botanical thought. On the other hand, we certainly do lose most of our interest in subjects before they become exhausted. One explanation which Professor S. W. Williston used to urge with some heat was that it was easier to pick up a new line than to master the literature of an old one. Twenty years ago he predicted that ecology would become as unpopular as taxonomy as soon as the literature was sufficiently voluminous.

You have all heard the students of taxonomy, both animal as well as plant, express grief, even exasperation, that so little attention is paid to their work. I can see no help for this. Neither last summer could the owners of "Tom Thumb" golf courses find any way to bring back the patrons who thronged their courses in 1930. I would urge those who find themselves almost deserted in a no longer fashionable field of botanical effort to cease railing against fate, for, to quote Justice Holmes:

> The law of fashion is a law of life. The crest of the wave of human interest is always moving, and it is enough to know that the depth was greatest in respect of a certain feature or style in literature or music or painting a hundred years ago to be sure that at that point it no longer is so profound. I should draw the conclusion that artists and poets, instead of troubling themselves about the eternal, had better be satisfied if they can stir the feelings of a generation, but that is not my theme.

THE DANGERS OF THE FAD

The dangers of the fad are obvious. All investigators are possessed more or less with what some one has called "the devil of one idea." When a group is so possessed we get something very like mob psychology, which results in an inevitable bias in observation and publication. Illustrations of this will occur to each of you. Many of you will recall—at least from the reproductions in early editions of Wilson's book the "Cell"—that Guiginard described and illustrated centrosomes in the lily. It was soon apparent, or at least generally believed, that no such structures exist, but under the impulse of the fad for centrosomes they appeared real enough to this cytologist.

Some of you will recall or have noted in the literature that Dr. T. J. Burrill, honored wherever pathology is studied as the first to demonstrate the possibility of bacterial disease in plants, described,

> *Micrococcus toxicatus*, Burrill. Cells globular, single and in pairs, rarely in chains of several articles; .00002 in. in diameter; *movement oscillatory only.*

This organism he believed to cause the poisonous principle of species of Rhus and to be capable of penetrating the human skin and inducing the peculiar inflammation which takes place. So enthusiastic was Burrill over this imaginary discovery that he published it in three different places. Those who in 1922 saw the unrestrained enthusiasm of the recognized leaders of plant pathology over the preliminary and possibly mistaken announcement of certain organisms in the cells of plants affected with mosaic diseases were witnessing no new phenomenon. Similar enthusiasm, if I may judge from the literature, greeted the alleged bacteria in poison ivy forty years earlier. In one of the great speeches of all time, Paul, standing on Mars Hill, is said to have addressed an audience "who spent their time in nothing else but either to tell or to hear some new things." This is a condition not wholly foreign to other audiences in other times, even American botanical audiences.

The danger in this sort of publication is, however, more apparent than real. A wise and tolerant botanical public, realizing that these great investigators were acting under the impulse of "fad psychology," soon forgets these slips, and the careful reader of tomorrow, noticing in the pathological literature of 1915 to 1925 an exceedingly large number of reports of virus diseases, will recall that virus diseases were all the rage in those days and will take these reports with more than a grain of salt.

Just as a man in good general health who consulted a physician between 1910 and 1920 was predestined to be diagnosed as having appendicitis, so a plant which showed any unusual abnormality between 1915 and 1925 was sure to be under suspicion of having some mosaic disease. Five years ago we were busily studying two diseases of strawberries which we regarded as of virus origin. One has since turned out to be caused by nematodes and the other is apparently a genetic variation.

THE ADVANTAGES OF THE FAD

A year ago I was convinced that fads, at least botanical fads, were an almost unmitigated nuisance. Somewhat more mature reflection, however, serves to convince me of the contrary. I now regard them with a toleration which approaches enthusiasm.

Something like a fad may be necessary to jar the human mind, even the botanical mind, from its old moorings. To cast out the devil of one idea from the botanical mind is often a decided advance. It may be that occasionally, when the devil of one idea is cast out he will return, and finding the botanical house swept and garnished, take seven other spirits worse than himself and enter in and dwell—which might appear worse. On the other hand, it may really be better, and at any rate they will not stay. New fads are often better than the old. I am glad, for example, that the fad for chewing tobacco has been replaced by the cigarette fad. I view with something very like dismay the possibilities if the ladies had all taken up tobacco during those earlier days. With almost equal dismay I view the possibilities if changes in American botanical interests had ceased at, for example, the embryo sac stage.

It may well be that the fad offers the only way to really introduce a new concept into the botanical world. By this I do not mean merely to get the idea into literature, but to get in into botanical thinking.

In his "Leaven of Science" Sir William Osler cites the following story, told by Sir Robert Christian, about Barclay, one of the leading anatomists of the early part of the nineteenth century. Barclay spoke to his class as follows:

> Gentlemen, while carrying on your work in the dissecting room, beware of making anatomical discoveries; and above all beware of rushing with them into print. Our precursors have left us little to discover. You may, perhaps, fall in with a supernumerary muscle or tendon, a slight deviation or branchlet of an artery, or, perhaps a minute stray twig of a nerve—that will be all. But beware! Publish the fact, and ten chances to one you will have it shown that you have been forestalled long ago. Anatomy may be likened to a harvest field. First come the reapers, who, entering upon untrodden ground, cut down great stores of corn from all sides of them. These are the early anatomists of modern Europe, such as Vesalius, Fallopius, Malpighi and Harvey. Then come the gleaners, who gather up ears enough from the bare ridges to make a few loaves of bread. Such were the anatomists of last century—Valsalva, Cotunnius, Haller, Vicq d'Azyr, Camper, Hunter and the two Monroes. Last of all come the geese, who still contrive to pick up a few scattered grains here and there among the stubble, and waddle home in the evening, poor things, cackling with joy because of their success. Gentlemen, we are the geese.

Osler's comment on this story is:

> Yes, geese they were, gleaning amid the stubble of a restricted field, when the broad acres of biology were open before them. Those were the days when anatomy meant a knowledge of the human frame alone; and yet the way had been opened to the larger view by the work of John Hunter, whose comprehensive mind grasped as proper subjects of study for the anatomist all the manifestations of life in order and disorder.

To Osler's comment I beg leave to add that probably only by strength of interest in various fads were the geese called away from their gleanings and but for the widening of interest induced by fads they and their successors might well have remained in the stubble.

OBITUARY

WICKLIFFE ROSE[1]

1862–1931

WICKLIFFE ROSE was educated in his native state of Tennessee and at the University of Chicago. The scope of his intellectual interests was manifested early and changed only in outward appearance as time and circumstances carried him into unfamiliar and unexpected fields. It is worth noting that his first teaching position was in history and mathematics—subjects which, while disparate in content, were yet both congenial to his mind. It was in philosophy, however, that he found his real vocation. He filled chairs of philosophy and the philosophy of education for more than ten years at Peabody College and the University of Nashville. Never afterwards did he lose the general and analytical point of view acquired in those formative years. In all his subsequent, varied activities he looked instinctively not only into, but around, his problems.

During this period his recognized talents, executive ability and devotion to education led to his selection as dean of Peabody College and the University of Nashville, as agent of the Peabody Fund and trustee of the John F. Slater Fund, both the latter appointments having to do with furtherance of education in the South.

It was doubtless while administering these funds that Dr. Wallace Buttrick, president of the General Education Board, came to know Dr. Rose and to appreciate his gifts. Thus it resulted that Dr. Rose was chosen in 1910 to be the director of the Rockefeller Sanitary Commission for the Eradication of Hookworm in the South, an undertaking which started him on the amazing career for the betterment of health and the upbuilding of science that was to assume world-wide dimensions.

It was not without trepidation that Dr. Rose entered upon the anti-hookworm campaign. The field seemed far removed from philosophy and education. He gave the opportunity minute thought and consideration, and it may well be believed that his natural humanitarian impulses and love of his country contributed to the affirmative decision. A wakeful night, it is said, brought conviction and yielded also a plan of operations. As many of us know the dangers and pitfalls of midnight vigils, it is proper to state that Dr. Rose's visions when tested proved to be realizable. It is an historical fact that the methods he put into practice at the outset later called for little modification even when applied on an international scale.

There was a critical moment in the year 1910 when Dr. Rose might have been lost to the great career awaiting him in the yet distant future. When the presidency of Peabody College was offered him, his heart returned to his first loves—philosophy and education. The decision to be made was difficult and had to be a final one. We met at Lake George, where, as I recall it, the Southern Education Board was in session. Dr. Rose, who was at home on the water, rowed me well out on Lake George, and then resting the oars told of his struggle. Tears came into his eyes as he described the pull of the old, academic life, and also the attraction of the opportunity for useful work just opening before him. My sympathies were deeply stirred, and I rejoiced when I felt that Dr. Rose would go on with the health project. No one could, of course, advise the choice, although the extraordinary future in store for him had already become apparent to his associates.

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[1] Read at the meeting of the National Academy of Sciences, Washington, D. C., April 26, 1932, at the posthumous award on Dr. Wickliffe Rose of the Marcellus Hartley medal for eminence in the application of science to the public welfare.

A notable authority has said that Dr. Rose was a pioneer in devising the best methods of applying private philanthropy to the problems of preventive medicine. The tribute may justly be broadened: he was equally a master in the difficult art of applying private philanthropy to the highest purposes of scientific education and research. The beginning was made in public health work, and for this hookworm eradication was the instrument. Here it was necessary to proceed with tact and caution. The sensibilities of states were aroused. Dangers were averted by the policy adopted at the outset of entering a field only upon the invitation of the government, to operate as an integral part of the constituted health authorities, to exalt the importance and efficiency of the official health agencies, and to avoid all appearance of outside intrusion.

These, which have proved to be sound principles, rested in their successful application on knowledge of the extent of hookworm infestation, of the terrain which differed with locality, the economic status of the region, and on a fundamental understanding of the biology of the hookworm and the best available methods for its eradication.

Here were scientific questions to be answered and problems to be solved—things very appealing to Dr. Rose's mind. The relief work was gotten quickly under way, and very soon the scientific studies followed. The booty was a wealth of new facts, and in time the mere eradication of hookworm infestation became the wedge for the enlargement of public health activities and the undertaking of scientific investigations in the field and laboratory of public health problems.

The difficult matter of a personnel trained for scientific public health work became increasingly pressing. The solution sought by Dr. Rose was characteristic of him. Looking ahead a long time, he saw public health officers of various kinds as constituting a virile force in modern civilization. Thus he became the prime mover and influence in leading the Rockefeller Foundation to create schools of hygiene, with large funds, in Baltimore, Boston, London and elsewhere. The results of this vast public health program, which was extended to more than fifty countries and nations often diverse in populations and local conditions, with adaptations suited to each, have been astounding as measured in health, wealth and good will.

In due time an attack on malaria was begun, first on a local and later on an international scale. Here again scientific studies preceded or went hand in hand with practical relief operations. And then came the great problem of yellow fever in the Western Hemisphere and in Africa. It is not, I think, too much to say that next to Walter Reed and his associates the world owes most in this respect to the fundamental conceptions of Wickliffe Rose. Employing scientific expeditions sent to the "seed beds" of the disease in order to establish its nature and if possible to discover its cause, and by bringing into play the resources of present-day science, he is responsible for Dr. Noguchi's discovery of the *Leptospira icteroides* and Dr. Stokes' discovery of the African virus of yellow fever. It now appears that the yellow fever of the Western Hemisphere is dual in character, being composed of two diseases—one produced by the leptospira, the other by an agent identical with the African virus. This discovery promises to have far-reaching implications in the efforts to eradicate the Western disease.

As is well known, the two intrepid investigators just mentioned, as well as still other scientists, lost their lives in the course of their studies on yellow fever. Out of these profound tragedies has already come a means of protecting laboratory workers from infection by a method of immunization which may prove to have great importance for the future.

In 1923, when Dr. Rose became president of the General Education Board and the International Education Board, he returned to the educational field. Applying his accumulated experience, he set to work at once in the building up of science in its teaching and research aspects, and addressed himself again to the essentials of the undertaking at home and abroad. Knowing the value of good counsel, he sought to obtain the best available. The resources at his command were large; he knew the value of conservation and of use. Characteristically he struck again at the root of opportunity. Seeking to advance knowledge, his method was to strengthen the strong; he was attracted to leading men, strong laboratories, present opportunity. His aid was given widely but irregularly, as the circumstances seemed to warrant. In every instance, first a survey and then an analysis were made. After due consideration, fortified by conference, judgments were reached. When action came, it was decisive and often courageous. Magnitude with him was a wholly relative matter: he weighed his acts in results to be achieved, rather than in costs to be met. Moderate expenditures were the rule, but large ones, as notably for the erection of the great two hundred inch telescope building at Pasadena, did not daunt him.

Although he was not a technical scientist, Wickliffe Rose became a great force in science. The temper of his mind was essentially scientific and he found no difficulty in dealing with scientists on their own grounds. I believe that he never discerned a problem in an unscientific manner; surely he never entered upon a project which he did not comprehend fully. It may be said of him that he enriched every field in which he worked; this is true of hookworm disease, malaria, yellow fever, and of the aid, small and large, which he gave to physics, chemistry, astronomy and biology.

In an interlude to his constructive activities he rendered valuable service as chairman of the War Relief Commission of the Rockefeller Foundation. In Belgium, Poland, Serbia and other countries ravished by war the assistance given under his direction to refugees, children and the destitute is gratefully remembered. He was responsible for the creation of the hospital unit at Compiègne where Drs. Carrel and Dakin worked out their method of treating infected wounds which played so beneficent and large a part in the late years of the war and afterwards in civil life.

Dr. Rose was remarkable in his self-effacement. No man, I believe, was ever more successful in this respect. He was moved by the opportunity for human betterment—of health, of knowledge, of personal relations. To those of us privileged to work beside him he was a constant wonder and joy. The ideality of his purpose, the clarity and comprehensiveness of his vision, the lucidity of his exposition, the security of his judgment, his good companionship, his love of a good story (especially a fish story, for he was an enthusiastic fly fisherman)—these are things not to be conveyed in mere words.

Simon Flexner

MEMORIALS

The annual meeting of the Research Club of the University of Michigan each year honors the work of some leader of science whose birth occurred one hundred years ago or some multiple thereof. The meeting on April 20 was a memorial to Benedictus de Spinoza and Anthony van Leeuwenhoek. The paper on Spinoza was read by Professor DeWitt H. Parker, of the department of philosophy; that on van Leeuwenhoek by Dr. C. V. Weller, head of the pathological laboratories. President Alexander G. Ruthven discussed the importance of research to the university.

The *Zeitschrift für Tuberkulose* has published a special Robert Koch issue containing his portrait and two facsimile letters, as well as original papers by E. von Romberg and Sauerbruch, each of Munich; Sir Robert Philip, of Edinburgh; Calmette and Léon Bernard, of Paris; Bruno Lange, of Berlin; Bang, of Copenhagen, A. Stanley Griffith, of Cambridge, and others.

The fourth "Victor Horsley Memorial Lecture" will be delivered this year, and the trustees (who consist of the presidents of the Royal Society, the Royal College of Surgeons of England, and the British Medical Association, the senior physician to the National Hospital, Queen Square, the senior surgeon to University College Hospital, and Mr. Stanley G. Robinson, the son-in-law of Sir Victor Horsley) have invited Professor E. D. Adrian, of the University of Cambridge, to give the lecture, and he has consented to do so. The lecture will be delivered on July 20 on the subject of "Visceral Sense Organs."

RECENT DEATHS

Professor James W. Toumey, a member of the faculty of the School of Forestry at Yale University since it was established in 1900, formerly dean of the school, died suddenly on May 6, at the age of sixty-eight years.

Dr. Charles Dwight Marsh, formerly physiologist in the U. S. Bureau of Animal Industry, died in Washington on April 23, at the age of seventy-seven years.

Dr. Wilfred W. Scott, head of the department of chemistry at the University of Southern California, died suddenly on May 3, at the age of fifty-six years.

Dr. T. C. Johnson, horticulturist and director of the Virginia Truck Experiment Station, died on March 31, at the age of sixty-two years.

The death is announced at the age of thirty-three years of Dr. George Janssen, assistant professor of agronomy and assistant agronomist at the Experiment Station at the University of Arkansas.

Nature reports the deaths of Professor W. R. Dron, Dixon professor of mining in the University of Glasgow; of Dr. Alfred Hay, sometime professor of electro-technology, Royal Indian Engineering College, Coopers Hill, and afterwards at the Indian Institute of Science, Bangalore; of Professor G. M. Robertson, professor of psychiatry in the University of Edinburgh; of Eustace Short, of the firm of Short Brothers, a pioneer in the design and construction of aeroplanes, and of Professor A. L. Urquhart, professor of pathology at the University of Cairo.

SCIENTIFIC EVENTS

THE YORK MEETING OF THE BRITISH ASSOCIATION

THE annual meeting of the British Association for the Advancement of Science will be held this year at York from August 31 to September 7. The president is Sir J. Alfred Ewing and he will deliver an inaugural address on the subject of "An Engineer's Outlook."

The London Times calls attention to the circumstance that the British Association had its beginning at York. It is recalled in the preliminary program for this year's meeting that when David Brewster in 1831 made the first concrete proposal for the foundation of a "British Association of Men of Science" he addressed it to John Phillips, the secretary of the Yorkshire Philosophical Society, on the grounds that York was centrally situated for a general meeting such as was contemplated and that the society already established there was flourishing and well managed. In the premises of the Yorkshire Philosophical Society, accordingly, the association was brought to birth on September 26, 1831, and continued its meetings on the following days.

The subjects of papers read depended largely upon the chance of individual men of science attending the meeting coming prepared with something to say, but the classification is not without interest. Six of the communications were on geology and mineralogy, five on magnetism and electricity, four on optics, three on light and lighting, while three were physiological, two meteorological, two chemical and one astronomical. Since 1831 the association has met at York in 1844, 1881 and 1906, and it returns to the city this year for the first meeting after the celebration of a century of existence.

The arrangements made for the 1932 meeting, according to the *Times*, include the presidential address in the Section of Mathematical and Physical Sciences by Professor O. A. Rankine on "Physics in Prospecting for Minerals"; there will be discussions on the control of humidity in industrial processes, the quantitative relation of physical stimuli and sensory events, super conductivity and short-wave reception by frame aerials. Dr. W. H. Mills will preside over the Chemistry Section and give an address on "Some Aspects of Stereo-chemistry." In the Geology Section the presidential address by Professor P. G. H. Boswell will be on "The Contacts of Geology: The Ice Age and Man." The president of the Section of Zoology will be Lord Rothschild. Professor H. J. Fleure will give a presidential address in the Geography Section on "The Geographical Study of Society and World Problems." There will be papers in the Section of Economic Science and Statistics on the location of industries, the effects of the world depression on the banking systems of Central Europe, and the economic position of Japan. The address of the section president, Professor R. B. Forrester, will be on "Britain's Access to Overseas Markets."

Professor Miles Walker is to preside over the Engineering Section, and give an address on "The Call of the Engineer to Manage the World." In the Anthropology Section the presidential address by Dr. D. Randall MacIver will deal with "The Place of Archeology as a Science." Other sectional presidential addresses will be as follows: Psychology—Professor Beatrice Edgell on "Current Constructive Theories on Physiology." Botany—Professor J. H. Priestley on "The Growing Tree." Educational Science—Mr. W. M. Heller on "The Advancement of Science in Schools." Agriculture—Professor R. G. White on "Sheep Farming; a Distinctive Feature of British Agriculture." Sessions of the Physiology Section will not be held at York, as the fourteenth International Physiological Congress is being held at the same time at Rome.

Two evening discourses have been arranged. Sir Arthur W. Hill will speak on "Plant Products of the Empire in Relation to Human Needs," and Mr. C. C. Paterson will deal with "Uses of the Photo-Electric Cell." There will also be a public lecture by Mr. H. E. Wimperis on "Speed in Flight." The Lord Mayor and the Sheriff of York will hold an evening reception on September 1.

WESTERN RESERVE CHAPTER OF SIGMA XI

THE fifty-ninth chapter of Sigma Xi has been installed at Western Reserve University. The chapter will assume the functions of the Science Colloquium, an informal scientific club which has been active in the university for many years.

Owing to illness, Dr. L. B. Wilson, national president, was unable to be present and the ceremonies were conducted by Professor Leon J. Cole, of the University of Wisconsin, and Professor Edward Ellery, national secretary. The installation ceremony was held in the Institute of Pathology, and was followed by a banquet at the Wade Park Manor Hotel and by an evening meeting in the auditorium of the Allen Medical Library addressed by President Wickenden, of the Case School of Applied Science.

Six members of the faculty were initiated to full membership. Two others were elected but were unable to be present for initiation. Fifty-eight members from other chapters now on the Western Reserve faculty affiliated themselves as charter members of the new chapter.

The officers elected for the first year are:

President, V. C. Myers.
Vice-President, H. S. Booth.
Secretary, J. A. Doull.
Treasurer, A. H. Hersh.
Membership Committee: (3 years), F. J. Bacon and T. Sollmann; (2 years), F. Hovorka and H. T. Karsner; (1 year), H. W. Mountcastle and J. R. Musselman.

At the installation meeting, following the presentation of the charter and the initiation of new members, Professor Cole gave a brief address on the history of the society and its objectives. This was followed by a symposium on methods of achieving the purposes for which Sigma Xi was organized. At the banquet short addresses were made by President Emeritus Thwing, President Vinson and Professor Cole. The subject of President Wickenden's address at the evening meeting was, "Science in a Changing World."

STATE ACADEMIES OF SCIENCE

THE Kansas Academy of Science held its sixty-fourth annual meeting at McPherson College, Kansas, from April 14 to 16. The program listed 114 papers of which over 100 were read. The attendance was about 250, not including local students. Professor L. E. Melchers, head of the botany department of the Kansas State College, gave a lecture on "The Oases of the Libyan Desert." At the banquet the presidential address was given by Dr. Roger C. Smith, of the Entomology Department of Kansas State College. His subject was, "Upsetting the Balance of Nature with Special Reference to Kansas and the Great Plains Region." There was an illustrated public lecture on "Tamest Africa," by Dr. S. A. Barrett, director of the Milwaukee Public Museum. The following officers were elected: Robert Taft, University of Kansas, Lawrence, *president;* J. Willard Hershey, McPherson College, *first vice-president;* Wm. H. Matthews, Kansas State Teachers College, Pittsburg, *second vice-president;* George E. Johnson, Kansas State College, Manhattan, *secretary;* Harvey A. Zinszer, Fort Hays Kansas State College, Hays, *treasurer*. The chairman of sections elected were: John Breukelman, Kansas State Teachers College, Emporia, biology; J. W. Hershey, McPherson College, chemistry; J. L. Bowman, McPherson College, physics; H. B. Reed, Fort Hays Kansas State College, psychology; R. H. Painter, Kansas State College, Manhattan, entomology; Hazel E. Branch, University of Wichita, Junior Academy. Additional members of the executive council are: R. C. Smith, Kansas State College; Wm. J. Baumgartner, University of Kansas; E. A. Marten, University of Wichita. Dr. F. C. Gates, Kansas State College, was reappointed editor.

GEORGE E. JOHNSON,
Secretary

The tenth annual meeting of the Virginia Academy of Science was held at Hollins College on April 21, 22 and 23. Six hundred registered and 120 papers were read. The invited speaker for the open meeting Friday night was Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, who spoke on "The Evolution of the Research Laboratory." The prize of fifty dollars, which is awarded each year for an especially meritorious paper read at the meeting, went to Dr. James H. Smith, of the Medical College of Virginia, for a paper entitled "The Influence of Solar Radiation on the Distribution and Prevalence of Exophthalmic Goiter in the United States." Professor F. J. Sette, of the Virginia Polytechnic Institute, was given a certificate for a paper entitled "A Study of the Pulaski Reservoir." The newly formed Section of Medical Sciences, organized by Dr. J. Shelton Horsley with its 80 members and a program of twenty papers, attracted especial attention. Dr. T. McN. Simpson, of Randolph-Macon College, was elected president for the coming year and Professor Ida Sitler, of Hollins College, to membership on the council.

E. C. L. MILLER,
Secretary-Treasurer

In connection with the twenty-fifth annual meeting of the Illinois Academy of Science, which convened at the University of Chicago on Friday, May 6, there was held by the section of anthropology a symposium on the prehistoric races of Illinois. Dr. A. R. Kelly, head of the department of anthropology at the University of Illinois, presided as chairman of the section, and also presented a paper dealing with archeological discoveries in the Cahokia Mounds region near St. Louis. Fourteen students of Illinois prehistory took part in the program, among them Dr. Fay-Cooper Cole, president of the academy and head of the department of anthropology and archeology at the University of Chicago. Dr. Cole spoke on "Field Methods Employed in Mississippi Valley Archeology" with special reference to past work in Illinois. The Academy of Science maintains separate sections in agriculture, anthropology, botany, economics, geography, geology, medicine and public health, physics and chemistry, psychology and education, and zoology, all meetings being open to the public. A banquet was held on Friday evening at the Shoreland Hotel, after which Dr. Cole delivered the annual public address of the retiring president on "The Coming of Man." On Saturday morning an inspection was made of the new Oriental Museum at the University of Chicago, and also of the Field Museum, the Adler Planetarium and the Shedd Aquarium group in Grant Park.

GEOLOGICAL SESSIONS AT THE SUMMER MEETING OF THE AMERICAN ASSOCIATION

SECTION E will hold sessions during the summer meeting of the association at Syracuse, New York, between Tuesday, June 21, and Friday, June 24. Arrangements for the sessions are being made by Dr. George B. Cressey, Syracuse University, local representative for Section E. On Tuesday there will be a joint session with Section M, consisting of a symposium on aerial photography and aerial mapping. Section E will also participate in the symposium dealing with land use, which is being arranged by the general committee for the Syracuse meeting. The Wednesday morning session will be devoted to papers on local physiography, including glaciation. In the afternoon a field trip will be taken to points of physiographic interest. On Thursday morning, in addition to general papers, there will be a number of reports on stratigraphy related to the classic New York section. In the afternoon a field trip will be arranged especially for stratigraphers. Friday, June 24, will be devoted to an all-day field trip in the Mohawk Valley and the Adirondacks.

Those who desire to present papers should send titles to the secretary promptly. Titles must be accompanied by abstracts of about 250 words, giving the substance of the paper, and the author should indicate whether he will use lantern slides, charts or other illustrative material. All titles and abstracts must be in the hands of the secretary not later than May 24, if they are to appear on the program.

KIRTLEY F. MATHER,
Secretary, Section E,
Harvard University

SCIENTIFIC NOTES AND NEWS

THE Theodore William Richards Gold Medal was presented to Dr. Arthur Amos Noyes, director of the Gates Chemical Laboratory of the California Institute of Technology, at a meeting of the Northeastern Section of the American Chemical Society in Boston on May 4. The program included a survey of the work of Professor Noyes by Professor Arthur B. Lamb, of Harvard University, president-elect of the American Chemical Society. Professor Lyman C. Newell, of Boston University, gave the history of the medal. William P. Ryan made the presentation and after accepting the medal Professor Noyes spoke on "Education for Chemical Research."

PROFESSOR MICHAEL I. PUPIN, of Columbia University, was recently tendered a testimonial dinner by friends at the Faculty Club, in honor of his having been made an honorary member last summer of the Royal Institution of London. Professor Pupin spoke on "Faraday, the Prophet in Science."

PROFESSOR E. W. BROWN, Stirling professor of mathematics at Yale University, has been made the first incumbent of the professorship of mathematics recently established in honor of Josiah Willard Gibbs.

DR. HELEN DEAN KING, assistant professor in the Wistar Institute of Anatomy and Biology of the University of Pennsylvania, and Dr. Annie J. Cannon, astronomer of Harvard Observatory, have been given jointly the $2,000 Ellen Richards Research Prize awarded annually by the Association to Aid Scientific Research by Women.

AT the annual meeting of the Boston Society of Natural History on May 4, the Walker prize was awarded to Thomas C. Brown, of Fitchburg, Massachusetts, for a paper on the "Glacial Geology of the Nashua Valley," while the second prize was awarded to Kenneth K. Landes, of the department of geology of the University of Kansas, for a paper on "Classification and Distribution of Pegmatites." The following officers of the society were reelected: Charles H. Taylor, *president;* Nathaniel T. Kidder, Glover M. Allen and William M. Wheeler, *vice-presidents;* Clinton V. McCoy, *secretary;* Augustus P. Loring, Jr., *treasurer;* Thomas Barbour, William L. W. Field, Frederic H. Kennard and John C. Phillips, *trustees.* John A. Blanchard and Ralph Hornblower are newly elected as trustees.

PARRY H. MOON, assistant professor of electrical engineering at the Massachusetts Institute of Technology, has been awarded the prize for the best paper presented during the year by the American Institute of Electrical Engineers, northeastern district. The paper is entitled "Theory of Thermal Breakdown of Solid Dialectrics."

Sir Aldo Castellani, of the London School of Tropical Medicine, is among four recipients of the Mussolini Prize of 50,000 lire (about $2,500) for special distinction in the past year.

Nature writes: "It is fitting that the autumn number (No. 3; 1931) of *Copeia,* a journal of cold-blooded vertebrates published by the American Society of Ichthyologists and Herpetologists, should have appeared as a special tribute to Leonhard Stejneger and his work. For Stejneger is to American cold-blooded vertebrates what G. A. Boulenger is on this side of the Atlantic. Endowed with great personal charm and a willingness to share his profound knowledge, to which the writer of this note has more than once been indebted, Stejneger is a man in whom great diversity of interests and talents has been combined. As Thomas Barbour in a tribute to his friend says, 'Being an antiquarian, a classicist, a rarely accomplished linguist, and a naturalist in the widest sense, he possessed a foundation on which with good health and great industry he has built a mighty structure of rarely excellent work.' The anniversary number, with its many papers on reptiles, amphibians, and fishes, is a fitting monument to this native of Bergen and graduate of the University of Christiania, who since 1882 has been associated with the Smithsonian Institution and since 1911 has been its head curator of biology."

The following new appointments have been made to the teaching staff of the George Washington University School of Medicine, Washington, D. C.: Errett Cyril Albritton, M.D., professor of physiology and executive officer of the department; Vincent du Vigneaud, Ph.D., professor of biochemistry and executive officer of the department; Leland W. Parr, Ph.D., associate professor of bacteriology; Roscoe Roy Spencer, M.D., associate professor of hygiene and preventive medicine; Chester E. Leese, Ph.D., assistant professor of physiology; John H. Hanks, Ph.D., assistant professor of bacteriology; Elizabeth Verder, Ph.D., assistant professor of bacteriology; George Brewer, M.D., instructor in physiology; Alden F. Roe, Sc.D., instructor in bacteriology; Phoebe J. Crittenden, Ph.D., instructor in pharmacology, and Lane H. Allen, M.S., instructor in anatomy.

Dr. Charles Edwin Friley has been elected dean of the division of industrial science of the Iowa State College to succeed the late S. W. Beyer. Dr. Friley goes to Iowa from the Texas State College, at which institution he occupied the position of dean of the College of Arts and Sciences.

Frank H. Moser has accepted a position as research chemist with the National Aniline and Chemical Company, Buffalo, New York.

Dr. Kurt Koffka, director of the Smith College research laboratory in experimental and educational psychology, has accepted an invitation from the State Institute of Psychology at Moscow to join a Russian scientific expedition to study isolated peoples in remote parts of the country. For the first time a foreigner is included in the personnel of one of the institute's expeditions. Dr. Koffka will lecture at Moscow and at Charkov on his experiments at Smith College.

According to the *Journal* of the Washington Academy of Sciences, E. P. Killip, associate curator of plants, U. S. National Museum, who left Washington early in February for study in European herbaria, reports satisfactory results at Berlin. After a month at the Museum d'Histoire Naturelle, Paris, Mr. Killip left for several weeks' work at the Royal Botanic Gardens, Kew, and the British Museum (Natural History), returning to Washington early in May.

J. Leland Myer, fellow of the Engineering Foundation, who is investigating pure iron for arc welding under Professor Gilbert E. Doan at Lehigh University, has transferred his work to the new laboratory of Professor Gustav Hertz, at Charlottenburg, Germany.

Dr. J. Bartels, who, as a research associate of the Carnegie Institution of Washington, has been engaged on the theoretical interpretation of the accumulated observational data at the Department of Terrestrial Magnetism in Washington, D. C., having completed his year's leave of absence from Germany, has returned to his position in the Forstliche Hochschule in Eberswalde.

A new search for Colonel P. H. Fawcett, the English explorer, his son, Jack, and his companion, Raleigh Rimell, reported as lost in the jungle in 1925 while seeking the cradle of Brazilian civilization and now thought by some to be alive, will be undertaken by a British expedition leaving England in June. The expedition, which also will explore Rio das Mortes in the heart of Brazil, will be led by Robert Churchward, who explored the Araguaya River in 1931, and Captain John G. Holman, who was born in Brazil and has spent the greater part of his life as a hunter and engineer in the interior.

Professor Gilbert Ames Bliss, of the University of Chicago, gave an address on "The Calculus of Variations and Quantum Theory" before the Mathematics Club of George Washington University on April 22.

DR. A. F. BLAKESLEE, of the department of genetics of the Carnegie Institution of Washington, lectured on the inheritance of taste and smell in man, at Goucher College on April 28.

DR. F. M. BECKET, president of the Union Carbide and Carbon Research Laboratories, gave the last Aldred Lecture of the year at the Massachusetts Institute of Technology on May 6. He spoke on the "Development of the Ferro-alloy Industry."

DR. A. POLICARD, Lyons, France, will deliver the eighth Harvey Society Lecture at the New York Academy of Medicine, on Thursday, May 19. His subject will be "Histochemistry: Present State and Future."

AMONG the Friday evening discourses of the Royal Institution, which were resumed on April 22 and continue until June 3, are the following: April 22, Professor J. B. S. Haldane, "Hereditary Transmission of Acquired Characters"; April 29, Professor H. Hartridge, "The Rival Theories of Hearing"; May 20, Professor Henry E. Armstrong, "Faraday at the Sign of the Hexagon," and "Coal Color and Constitution," and May 27, Sir Walter Fletcher, "New Conceptions of Medical Research."

THE District of Columbia Chapter of Sigma Xi is the first non-institutional chapter of the organization to be granted the privilege of electing members. Under the new provision of the national constitution, Dr. Charles Greeley Abbot, secretary of the Smithsonian Institution; Dr. William Alanson White, superintendent of the Government Hospital for the Insane, and Dr. Roy Smith Bassler, curator of geology at the National Museum, were presented with the insignia of the society at the annual meeting on April 26. They responded with brief addresses on their fields of investigation.

AT its recent meeting in Philadelphia the American Society for Experimental Pathology elected the following officers for the coming year: *President,* Dr. Peyton Rous; *Vice-president,* Dr. Carl V. Weller; *Secretary-treasurer,* Dr. C. Phillip Miller, Jr.; *Councilor,* Dr. S. Burt Wolbach; *Councilor,* Dr. Oskar Klotz.

AT the twenty-sixth annual meeting of the American Society of Biological Chemists, held at the University of Pennsylvania, from April 28 to 30, the following officers were elected: *President,* Harold C. Bradley, University of Wisconsin; *Vice-president,* W. Mansfield Clark, the Johns Hopkins University; *Secretary,* Howard B. Lewis, University of Michigan; *Treasurer,* Cyrus H. Fiske, Harvard Medical School; *Councilors,* Paul E. Howe, U. S. Department of Agriculture; William C. Rose, University of Illinois, and D. Wright Wilson, University of Pennsylvania.

AT the recent annual meeting of the Electrochemical Society, the following officers were elected: *President,* R. A. Witherspoon, of the Shawinigan Chemicals Ltd., Montreal; *Vice-presidents,* Duncan MacRae, E. M. Baker and Sterling Temple; *Managers,* Acheson Smith, O. P. Watts and W. S. Landis; *Treasurer,* R. M. Burns; *Secretary,* Colin G. Fink. The convention was well attended and the sessions on fertilizers, copper by-products, and electric furnaces were unusually attractive. Reports from various centers showed increasing activities in the electrochemical industries.

THE council of the Geological Society of America has made the following announcement of nominations for officers for 1933: *President,* Dr. C. K. Leith, professor of geology, University of Wisconsin; *Vice-presidents,* Dr. Elwood S. Moore, professor of economic geology, University of Toronto; Dr. Rollin T. Chamberlin, professor of geology, University of Chicago; Dr. Edward M. Kindle, chief, division of paleontology, Canadian Geological Survey (from the Paleontological Society); Herbert P. Whitlock, curator of mineralogy, American Museum of Natural History, New York (from the Mineralogical Society); *Secretary,* Dr. Charles P. Berkey, professor of geology, Columbia University; *Treasurer,* Dr. Edward B. Mathews, professor of mineralogy and petrography and head of the department of geology, the Johns Hopkins University; *Editor,* Joseph S. Stanley-Brown, Robinson and Company, New York; *Councilors for 1933–1935,* Dr. Frank F. Grout, professor of geology and mineralogy, University of Minnesota, and Dr. W. O. Hotchkiss, president, Michigan College of Mining and Technology; *Representative of the Cordilleran Section,* Dr. Andrew C. Lawson, professor of mineralogy and geology, University of California; *Representative on the National Research Council,* Dr. Donald C. Barton, consulting geologist, chief of the division of the Rycade Oil Corporation. The present members of the council who will serve during 1933 also are Dr. Sidney Powers, chief geologist, Amerada Petroleum Corporation; Dr. Donnel F. Hewett, U. S. Geological Survey; George W. Stose, U. S. Geological Survey; Dr. Frank R. Van Horn, professor of geology and mineralogy, Case School of Applied Science; Dr. Alfred C. Lane, Pearson professor of geology and mineralogy, Tufts College, past president, 1932–1934, and Dr. Reginald A. Daly, professor of geology, Harvard University, past president, 1933–1935.

THE meeting in United States of the sixteenth International Geological Congress, originally planned for the summer of 1932, has been postponed for a year. Circulars with full information concerning the meetings will be distributed by the general secretary of the congress.

THE Pacific Section of the Botanical Society of America will meet with the Pacific Division of the American Association for the Advancement of Science at Pullman, Washington, on June 15, 16 and 17. The sessions will be of the usual type and all members of the society are cordially invited. The society will join with the American Association in its summer meeting at Syracuse. The meeting will be held on June 21, 22 and 23 and will follow the plan of its recent independent summer meetings. No papers will be read. Emphasis will be placed upon field trips and informal demonstrations and discussions. In the field trips the society will join with the Zoologists, the Ecological Society of America, the American Fern Society, the Torrey Botanical Club and others. Visits will be made under competent leadership to areas representative of the rich flora of Central New York. One all-day and two half-day excursions will be made, with an opportunity for the collection and preservation of specimens. In the fields of cytology and physiology it is expected that there will be demonstrations and informal discussion of exhibits.

THE fifth symposium in Theoretical Physics at the University of Michigan will be given in connection with the Summer Session beginning on June 27 and ending on August 19. In addition to other courses in experimental and theoretical physics offered by the Department of Physics, the following special series of lectures and seminars will constitute the symposium: "Selected Problems in Quantum Mechanics," Professor Werner Heisenberg; "Structure of the Atomic Nucleus," Professor George Gamow; "Theory of Hyperfine Structure of Spectral Lines," Professor Samuel A. Goudsmit; "Theory of Band Spectra," Professor David M. Dennison; "Quantum Mechanics," Professor Samuel A. Goudsmit, and "General Colloquium and Theoretical Seminars." A special announcement giving additional information about the work and accommodations may be had by writing the director of the physical laboratory, University of Michigan, Ann Arbor.

THE seventh annual meeting of the Acoustical Society of America was held on May 2 and 3 in the auditorium of the Bell Telephone Laboratories, New York City. At this meeting were reported the latest developments in electrical recording and reproducing of sound and in the acoustic aspects of radio broadcasting. Dr. Leopold Stokowski spoke on "New Horizons in Music" and H. A. Frederick, of the Bell Telephone Laboratories, on "Recent Fundamental Advances in Mechanical Sound Records on Wax Discs." He gave a demonstration using records produced by the vertical cut method. J. P. Maxfield, of Electrical Research Products, Inc., described the acoustic pick-up for broadcasting the Philadelphia Symphony Orchestra. At the Tuesday morning meeting, the following papers were presented: "Acoustics of Broadcasting and Recording Studios," by G. T. Stanton and F. C. Schmid, of Electrical Research Products, Inc., and "Control of Broadcasting Pick-up from Studios," by C. G. Jones and J. P. Maxfield, Electrical Research Products, Inc.

LEADERS in industry representing both large and small concerns will convene at the Pennsylvania State College on May 19 and 20, for the thirteenth annual Industrial Conference sponsored by the School of Engineering. The general theme of the two-day session will be engineering education and the growing need for engineers in the sales and distributing forces of the country. Among the business executives who will participate in the conference will be C. S. Coler, Westinghouse Electric and Manufacturing Company; L. W. Kempton, American Steel and Wire; C. R. Beall, Union Switch and Signal; O. W. Eshbach and Col. R. I. Rees, American Telephone and Telegraph; F. M. Feiker, director of the Bureau of Foreign and Domestic Commerce, Washington, D. C., and Dean Dexter S. Kimball, college of engineering, Cornell University.

THE Fourth International Patents Exposition opened at the Grand Central Palace on May 10 and will close on May 29. The sponsors of this organization, of which Major-General George O. Squier is honorary chairman, and Herman Larson is managing director, have been engaged for several years in collecting all sorts of inventions from all parts of the world. The forthcoming exhibition will be the first to be made in New York, and this will be a forerunner of a more extensive exposition to be made at the World's Fair in Chicago next year.

THE annual Congress of the Royal Institute of Public Health is being held in Belfast from May 10 to 15, under the presidency of the Marquess of Londonderry. The congress has been divided into the following Sections: (I) State Medicine and Municipal Hygiene; (II) Industrial Hygiene; (III) Women and Children and the Public Health; (IV) Tuberculosis; (V) Pathology, Bacteriology and Biochemistry. The inaugural meeting was held in the Great Hall of Queen's University, at 11 A. M. on May 10, when the presidential address was delivered. Several general excursions were arranged, besides sectional visits to hospitals, sanatoria, etc., and certain institutions, centers and works were open for inspection.

DR. C. G. ABBOT, secretary of the Smithsonian Institution, writes: "Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography of the

University of California, has solicited the aid of the Smithsonian in rehabilitating the library of the Geological Institute of the Kyoto Imperial University, whose entire collections of specimens and publications were destroyed when that establishment was burned recently. I venture to bring the matter to your attention and to ask whether you will be good enough to insert in SCIENCE an appeal for geological publications for the library of the Geological Institute. Any publications donated for that purpose may be forwarded here for transmission through the International Exchange Service to Japan. Beyond the transportation charges to Washington, which should be prepaid, there would be no cost to the senders of the publications in forwarding them to Japan. Packages should be addressed to "The Smithsonian Institution, International Exchange Service, Washington, D. C.," a letter of announcement being sent to the institution at the time of shipment."

The Museum News reports that a six-story building to be called the Maison Française has been included in the plans for Rockefeller Center, New York. It will occupy the northwest corner of Fifth Avenue and Forty-ninth Street, and will contain four hundred and thirty-seven exhibits on the art, industry and trade of France. In design it will duplicate the British Empire Building planned for the southwest corner of Fifth Avenue and Fiftieth Street.

A GRANT of $1,232,652 from the Rockefeller Foundation to McGill University for the establishment of a neurological institution was recently announced. The cooperation of both provincial and civic authorities in this work has been assured; more than $150,000 has been pledged by friends of the university and members of the governing board, and plans are well under way to develop at the university a neurological center that will be second to none on this continent. The establishment of the institute will involve the construction of a new building, specially equipped for research in neurology, neurosurgery and the physiology and pathology of the nervous system. Dr. Wilder G. Penfield, clinical professor of neurological surgery at the university, has been appointed director. He will be assisted by a staff headed by Dr. Colin Russell, Dr. F. H. MacKay and Dr. W. V. Cone.

THE twenty-first annual report of the Brooklyn Botanic Garden, 1931, calls attention to the fact that during the past year the attendance at the Botanic Garden was nearly 96,000 more than the year before, and the permanent endowment funds increased by $12,420. The total attendance for the year was more than 1,100,000, equal to nearly half the population of Brooklyn, and the permanent endowment fund is now nearly $1,004,000. The report calls attention to the extensive educational program of the garden, including the extensive cooperation with the public and private schools of greater New York. The school service included the supplying of nearly 5,500 Petri dishes filled with sterilized agar for the classes in biology in the high schools of all five boroughs of greater New York, and the supplying of living plant material for botanical and nature study work to more than 5,700 teachers for the instruction of nearly 224,000 pupils. A special section of the report is devoted to the research work in progress at the garden along the lines of plant pathology, disease resistance in plants, forest pathology, especially in connection with the chestnut blight, an extensive beardless iris project, and work in systematic botany and genetics. Seven students are enrolled at the garden for graduate study and other research.

DISCUSSION

MISNAMED CULTURES AND STUDIES OF THE TUBERCLE BACILLUS

ONE of the recent trends of research with the tubercle bacillus, as reported in the literature, has been the attempts to demonstrate variations in that organism. The effect of these reports apparently has been to create a belief that the original Koch bacillus is only one form of a highly variable micro-organism. This belief has led certain research workers to use in their studies organisms which they designated as tubercle bacilli but which, in all probability, were only acid-fast saprophytes.

The only definite criteria for identifying an organism as a tubercle bacillus are those based upon the personal observations of the workers, since there is no adequate description given in the various classifications. We believe that an organism upon isolation from lesions or any other natural source should conform in general to the following description, in order to be classed as a human or bovine tubercle bacillus.

(1) It grows between 30 and 40° C., the optimum temperature being 37° C.

(2) It is a slow grower, requiring about 4 days to 1 week for visible growth to occur, and 2 to 4 weeks to reach its full development.

(3) It does not grow on plain agar.

(4) It grows only on the surface of liquid media, and the inoculum must be floated on the surface. There is no clouding of the medium at any time.

(5) When grown on liquid media, it produces the essential substances of tuberculin, *i.e.*, it will produce the tuberculin reaction when injected into tuberculous animals.

> (6) To quote Calmette, "One should regard as tubercle bacilli only those which, when introduced into the body of a susceptible animal, such as the guinea pig, produce tuberculous lesions inoculable in series."

The identity of a stock culture which is labeled a human or bovine tubercle bacillus in any laboratory or collection, and which has properties markedly different from the above, should be questioned, unless it can be proved a descendant of a true tubercle bacillus.

We have noted that in three recent papers in the journals by Isaacs[1], Eberson and Sweeney[2] and Reed and Rice,[3] and in one published in 1913 by Wherry,[4] the descriptions given of an organism used as a human tubercle bacillus would lead one to suspect that the organism was only an acid-fast saprophyte. The culture employed was the same in each instance. Likewise, in the first study of the series by Reed and Rice,[5] it seems probable that a second saprophyte was used under the impression that it was a bovine tubercle bacillus. Subsequently, we obtained transfers of the two organisms, studied their cultural characteristics and investigated their histories.

The human saprophytic tubercle bacillus was listed as culture 607 in the American Type Culture Collection. The description was as follows:

> R. D. Herrold, John McCormick Institute for Infectious *Diseases, Chicago.* *Original strain of* Koch, brought over by Novy in 1888. Has lost virulence and grows profusely and quickly on artificial media.

Inasmuch as the culture came from Dr. Novy, we addressed a letter to him, and quote the reply in part as follows.

> I have your recent letter of inquiry regarding the tubercle bacillus which you mention as having the history of being brought from Koch's laboratory in 1888. Many years ago Dr. Vaughan was engaged in the study of bacterial proteins and this culture was used by him in the belief that it was a direct descendant of that which was brought from Berlin. I have always been very much in doubt about the matter and I have suspected that a mistake had entered into the history. About five years ago I again mentioned the matter to Dr. Vaughan and told him that I suspected that he had received a lot of saprophytic tubercle bacilli from someone and that a mixup must have taken place. I can not give you any exact history of the culture because the material was entirely in the hands of men in Dr. Vaughan's laboratory and only much later on was the culture taken over by my department, but I have always called it a saprophyte rather than by the name which refers to Koch's original culture.

The properties of the culture as brought out by our study are as follows:

> Microscopically. Acid fast when destained with 3 per cent. HCl in 90 per cent. ethyl alcohol. Morphology similar to that of the tubercle bacillus.
>
> CULTURAL CHARACTERISTICS
>
> *Dorset's egg medium.* Abundant growth in 48 hours at 30 or 37° C., good growth after 48 hours at 20° C. Finely wrinkled, spreading growth becoming bright orange after several days.
>
> Plain agar. Good growth in 48 hours.
>
> Glycerine, phosphate, beef infusion broth. Inoculum very hard to sink. Heavy, very coarsely wrinkled, tan-colored membrane over the whole surface after 4 days at 37° C.
>
> Dorset's asparagin, mineral salts medium. Develops more quickly when 1 per cent. mannite is present than when 3 or 7 per cent. glycerine is present. Clouding of the medium occurs after about two weeks.

It was reported in one of the papers[4] that culture 607 did not produce an allergic condition, *i.e.*, that a second inoculation with bacilli known to be virulent did not evoke the usual local reaction in animals inoculated with the saprophytic strain. In another paper[3] it was stated that the culture did not produce tuberculosis in guinea-pigs.

The bovine saprophytic tubercle bacillus was described as culture 599 in the American Type Culture Collection catalog as follows:

> N. J. Lynch, Shelton, Conn. 69a. Original culture American Museum Natural History. 69a came to the museum from the University of Buffalo where it was isolated from tubercles in lungs of cow. 1921. It is non-pathogenic and grows profusely and rapidly.

In a letter dated March 27, 1931, Dr. Lynch, Shelton State Tuberculosis Sanatorium, Shelton, Connecticut, gave us the following information. This culture was sent to him from the American Museum of Natural History as a bovine culture (69a). It grew rapidly but always retained its acid resistance and was non-virulent when inoculated into guinea-pigs and rabbits.

According to our study, the characteristics of this organism are like those of culture 607, except that it develops more slowly at 20° C., requiring one week to attain a good growth at this temperature.

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[1] M. L. Isaacs, "Factors which Influence Tests of Bacterial Survival. I. The Effect of Varying Periods of Incubation of the Survival Test Culture," *J. Bact.*, 20, 161, 1930.

[2] F. Eberson and M. A. Sweeney, "Tinctorial Transmutations of Acid-fast Micro-organisms and Virulence of Tubercle Bacilli," *J. Infectious Diseases*, 49, 301, 1931.

[3] G. B. Reed and C. E. Rice, "Studies in the Variability of Tubercle Bacilli. II. Correlation of Colony Structure, Acid Agglutination, and Virulence," *Can. J. Research*, 5, 111, 1931.

[4] W. B. Wherry, "Some Chemical Changes Favoring the Production of Spores in *Bacillus tuberculosis*," *Zentr. Bakt.*, etc., Orig. 70, 115, 1913.

[5] G. B. Reed and C. E. Rice, "Studies in the Variability of Tubercle Bacilli. I. A Rapid-growing Bovine Type," *Canadian J. of Research*, 4, 388, 1931.

In view of both the cultural characteristics and the history of these cultures, it would seem that there is little or no basis for considering them tubercle bacilli. It is most unfortunate that the results of these three research projects were published as contributions to our knowledge of the characteristics of the tubercle bacilli.

The misleading information thus placed in the literature becomes part of the history of the tubercle bacillus, and through references thereto by the authors of subsequent papers is perpetuated. As an example, we found in a paper by Sweany[6] a reference to Wherry's paper[4] as follows "By growing '801'[7] (the original Koch strain) on synthetic media with various alcohols, Wherry, in 1913, produced spore-like bodies in the bacillus and altered the acid fast staining qualities very markedly."

The blame for these misnamed cultures can not be placed on the curators of type culture collections. Such collections can be only depositories, and it must be the responsibility of each worker to check for himself the identity of the cultures which he uses. We wish to emphasize this point in order that further work with the tubercle bacillus may mean progress rather than confusion in the field.

E. G. HASTINGS
JANET MCCARTER

UNIVERSITY OF WISCONSIN

READING KNOWLEDGE

THE inadequate language equipment of the average American student and research worker in science is fairly well known. Its consequences, however, are hardly well enough realized. It might serve a purpose to focus attention on this important point by giving a few illustrations. They have not been collected by any systematic search. On the contrary, they all happened to come to the writer's attention on one single day, when he had occasion for looking through the chief American contributions in a very limited field. In all, half a dozen papers by American authors were consulted. In this limited material, two instances were found where an inadequate knowledge of German had led the authors in question to fundamentally wrong interpretations on important points.

One author writing in *Soil Science* says:

> Winogradsky found the nitrate-forming organism in his cultures in two stages, one of which he terms "schwärmer" and the other the "free cell stage." It is doubtful if such forms were present in this work, though such might have been the case. The free-cell type was common in all the cultures, and many strains showed great masses of the organisms which resembled very closely the "schwärmer" stage; however, this latter character of growth differed but slightly from the forms found as free cells . . . although the organisms within the group were occasionally slightly smaller.

The passage quoted is about the only one in the paper from which it could be gathered with some definiteness how the American organism studied compares with the classical Nitrosomonas of Winogradsky. As the statement stands, however, it is devoid of any sense. Apparently because of an insufficient knowledge of German, the author must have taken "Schwärmer" to mean the so-called zooglea form, instead of the free, motile monad form which the German term actually signifies. But the zooglea and the monads represent the two opposite extremes within the series of forms characteristic of these organisms.

In a recent contribution in *Centralblatt für Bakteriologie,* dealing with the same organisms, an American author discusses the findings of a German colleague as follows:

> In this way he secured a culture which was either a new form having power of multiplication in 0.3 per cent. peptone solution or his culture was impure.

Then comes a reference to a footnote, reading:

> Heubült says: "Ohne Zusatz organischer Substanzen findet eine normale Entwicklung statt, auch konnte ich bei einer Zugabe von 0.5% [in the original 0.05%; L.G.R.] Glukose kaum eine Wachstumshemmung feststellen. Dagegen war z. B. bei einem Zusatz von 0.3% Pepton oder 2.0% Natr. butyric. überhaupt kein N_2O_3 nachzuweisen, noch fand Wachstum statt, wie die mikroskopische Kontrolle zeigte."

The American author has evidently translated "noch" by "still" or "yet," instead of by "nor," as would have been correct. Because of this error, he quotes the German author as having found exactly the opposite of what he actually did, and his comment is worded accordingly.

It is to be hoped that the present findings do not represent average conditions. But it seems to be too much in any branch of science to find errors such as those quoted in one third of the papers consulted, and this in papers justly claiming international attention, published in technical journals of high standing. This can not contribute to the international respect for American science. As long as the certified reading knowledge of American graduate students and Ph.D.'s remains as uneven as it is, it would seem to be a minimum requirement on the responsible institutions that some control be exercized before its results are exhibited in international journals, and preferably before they are at all presented in print.

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[6] H. C. Sweany, "The Granules of the Tubercle Bacillus," *Am. Rev. Tuberc.,* 17, 53, 1928.

[7] Wherry's culture "801" has been identified as American Type Culture Collection Culture 607.

Although not directly belonging to the subject, it is hard to refrain from quoting a last oddity found in the bunch of papers referred to above. Harmless as it is, it is instructive by illustrating once more the surprising linguistic illiteracy which can be found in scientific papers. In a publication from Georgia, one finds a printed slip of paper with corrections, one of which reads: "p. 11: 'Vitality' should be 'virility.'" Looking up the page, it appears that no other organisms are mentioned than bacteria, which can not well be virile according to common ideas on the subject. Possibly "virility" was the author's version of "virulence," in his younger days.

L. G. ROMELL

CORNELL UNIVERSITY

RECENT FIND OF MAMMOTH REMAINS IN THE QUATERNARY OF FLORIDA, TOGETHER WITH ARROW-HEAD

IN September, 1931, Miss Thelma Van Buskirk, a student in Rollins College, brought to the museum a tusk and a tooth found by her brother, Mr. Allen Van Buskirk, a U. S. Government official, during his inspection of canal dredging near Flagler Beach, Florida. These fossils were determined as mastodon remains on basis of illustrations and descriptions in literature, especially Osborn's (1923) "Mastodons and Mammoths of North America." Photographs were made and sent to the Smithsonian Institution, which kindly confirmed the zoological determination.[1]

At my request, Mr. Van Buskirk kindly accompanied me to the spot where he had obtained the objects, and stated that a friend had recently struck some bones near-by while plowing.

Arrangements were immediately made with the owner of the property, Mr. Ed. Johnson, for Rollins College to continue excavations in search of further possible fossils.

About three hundred feet from the point in the canal where the mastodon remains were found, and about ten paces from the point where the plow struck bones, a party of eight[2] started to excavate. Various fossils, as will be described later, were found before much more than a cubic yard of material was removed. Suddenly a large, hard object was located about two and one half feet below the soil surface. In attempting to free this structure, which was entirely under water in the hole that was made, it became necessary to work around and under it with the bare hands; in this manual exploration, a cavity was felt in the surface directed at the time away from the soil surface (*i.e.*, downward). This cavity proved to be large enough to permit the insertion of my hand, thus making possible the careful withdrawal of its wet, loose content. This content contained an arrow-head; the material of which it was made was later determined by Professor J. E. Spurr as chert.

The large object in question, upon being removed, proved to be a pair of lower jaws, each jaw bearing a large tooth. This structure was determined (on basis of comparison with similar local museum material and with literature) as being remains of a mammoth.[1]

The geological formation immediately underlying the horizon in which the fossils occur was determined by J. E. Spurr as a shell marl of late quaternary age; the fossils themselves occur in sandy layers mixed with much organic (vegetable) material.

In addition to the foregoing, one complete needle-like object, and three broken pieces of similar nature, were found from one to seven feet away from, and in the same layer with, the mammoth jaw. These will be described more in detail later.

Excavations are being continued by the students, as time permits, in the hope of obtaining additional data which may possibly prove of value in connection with the question as to the antiquity of man on this continent.

JACK H. CONNERY

THOMAS R. BAKER MUSEUM,
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WINTER PARK, FLORIDA

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR THE DISARTICULATION OF SKULL BONES

HAVING need of a disarticulated cat skull, the method of filling the skull with dried peas and soaking was resorted to, but repeated trials gave unsatisfactory results. Perhaps due to unequally distributed pressure, the parietals and occipitals were pushed off as a group and the pressure was thus released before complete disarticulation could occur.

It was conceived that some method which would give considerable pressure in all directions in equal degrees would probably correct the faults observed when the dry seed method was used. It was subsequently decided that if the cranium could be filled with water and then subjected to freezing temperature, such a result might be realized, but the question then arose as to just how the water might be retained in the cranial cavity.

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[1] Later, this determination was concurred in independently by W. W. Holmes, C. W. Stiles, Gene Stirling, and J. H. Chase.

[2] A professor, Dr. Frank Guy Armitage, six students, Harold Cochenour, Guilford Galbraith, Daniel Havens, Robert Maclay, Douglas Riggs, and Jack Connery, and one visitor, Kenneth Wooldridge.

It was decided that probably the best manner to fill the skull cavity with water was to first place the water in physical combination with some such substance as gelatine. This was done. Cat skulls were soaked over night in water, then placed in warm dilute gelatine cooled to the solidifying point, then placed in a refrigerator at 0° F, excess gelatine having first been removed from the outside of skull, and the next day the skull was removed from the refrigerator and the ice melted by addition of warm water. The skulls treated in this manner disarticulated very satisfactorily. Skulls soaked in water only and frozen gave negative results. Further experimentation has shown that dilute agar is superior to gelatine.

The method as it is now used is as follows: (1) Soak skulls in water for twelve to twenty-four hours (dry skulls give fair results). (2) Place skulls in warm agar (above 45° C) made by boiling 7.5 gms of agar shred in one liter of water till the shreds have all dissolved. (3) Being sure that the liquid agar has completely filled the cranial and nasal cavities, cool to room temperature, remove the skulls from the solidified mass and freeze. (4) Wash frozen skulls with warm water and with slight leverage with the fingers remove such bones as may not have already fallen loose. (5) Remove any adherent agar with a stream of warm water and bleach bones if desired.

The method has been tried with cat, dog and turtle skulls, and has proven very successful with the first two, but the turtle skull is strongly articulated and further it offers almost no surface upon which pressure can be exerted. The method should prove successful with skulls of many animals, including the human.

I. A. WILES

DEPARTMENT OF ZOOLOGY,
WEST VIRGINIA UNIVERSITY

DISCARDED ROENTGEN RAY FILM FOR THE MOUNTING OF MUSEUM SPECIMENS

WE have found that discarded Roentgen ray films serve admirably as material on which to mount certain museum specimens. Film lends itself well to the mounting of small specimens of light weight such as gall bladder, bowel, aorta, and organs of small laboratory animals.

It is our practice to immerse the film in hot water until the emulsion softens, then this is scraped off. The film is allowed to dry and then cut to the desired size. It is well to make an exact fit for the inside of the usual museum jar. The fixed specimen to be mounted is then sewed to the film by means of needle and thread passed through holes that have been punched in the film in appropriate places. The specimen is then placed in the jar, fixing fluid added and the vessel sealed.

The method has obvious advantages: (1) Specimens are suspended in the jar on an invisible material; (2) since the film is transparent, both sides of the specimen are visible; (3) the film is a waste product and usually available and unbreakable; (4) the more cumberson glass frame suspension method with possibility of a broken frame can be dispensed with.

HAROLD D. CAYLOR

CAYLOR-NICKEL CLINIC,
BLUFFTON, INDIANA

A NOTE ON THE DETERMINATION OF IRON IN BLOOD AND BIOLOGICAL FLUIDS[1]

IN the determination of iron in blood, milk,[2] etc., as the ferric sulphocyanate, a mixture of amyl alcohol and ether is used to extract the color produced, after the addition of the sulphocyanate. Workers using this procedure are aware of the disagreeable odor, and irritating effect of amyl alcohol upon the mucus membranes of the nose and throat. In an attempt to overcome these objectionable features other substances were tried as a substitute for amyl alcohol, and ethylene glycol monbutyl ether[3] was chosen as the most suitable one.

For the extraction of ferric sulphocyanate the ethylene glycol monobutyl ether is mixed with an equal volume of ethyl ether. The extracted color is more intense than that extracted by amyl alcohol, and it does not seem to fade after standing 24 hours. The new medium proposed has no irritating effect upon the mucus membranes, and no disagreeable odor.

ADOLPH BERNHARD
I. J. DREKTER

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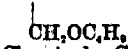
[1] From the Achelis Laboratory and A. Jacobi Division for Children, Lenox Hill Hospital, New York.

[2] J. H. Yoe, "Photometric Chemical Analysis," Vol. I, 1928, John Wiley and Sons, N. Y., p. 218-ch. 20; R. P. Kennedy, *J. Biol. Chem.*, 74: 385, 1927; C. A. Elvehjem, *J. Biol. Chem.*, 86: 463, 1930; R. Stugart, *Ind. Eng. Chem.*, Anal. Ed., 3: 390, 1931.

[3] Ethylene glycol monobutyl ether  $\begin{array}{l}CH_2OH\\ |\\ CH_2OC_4H_9\end{array}$ was obtained from the Carbide and Carbon Chemicals Corporation, New York City.

SPECIAL ARTICLES

THE INACTIVATION OF MOSAIC DISEASE VIRUS BY PULVERIZING INFECTED TISSUE

DUGGAR and Armstrong,[1] employing a motor-driven pestle in an agate mortar, found that the virus of tobacco mosaic disease is resistant to 9 hours' grinding. Using a different method, we have also been impressed with the difficulty of inactivating the virus. Complete resistance to grinding would indicate a property not usually associated with animate material; hence the importance of studying this question. We have now found that prolonged comminution of infected plant tissue results in loss of its infectivity. The possibility that the inactivation may be due to oxidation or adsorption has been investigated.

METHODS

The top leaves of several hundred tomato plants with mosaic disease were dried, and powdered by grinding for five minutes with mortar and pestle. This procedure caused no appreciable loss in virus potency.

Varying but measured amounts of the powder were placed with four polished steel balls, 1.1 cm in diameter, in Pyrex bottles[2] specially made to withstand breakage. The vessel was actively agitated in a shaking machine. Virus powder could escape comminution only by clinging to the sides of the bottle above the moving balls. Hence samples were taken only from the bottom of the container. For anaerobic pulverization, a sealed rubber stopper was used, through which passed a glass tube for attachment to the Boëz apparatus.[3] The indicator of relative anaerobiosis was 0.01 per cent. methylene blue in dextrose broth. 0.1 cc was placed in an unsealed ampoule with a double constriction of its neck to prevent leakage. It was protected by a wire cage which was attached to the lower surface of the stopper. A separate anaerobic container was used for each test material. Ten experiments were made and samples pulverized for periods up to twelve hours, were injected into 335 tomato plants.

In three adsorption tests virus powder was mixed with normal plant powder which had been pulverized 4 and 10½ hours, respectively. This mixture was either shaken for 3 hours and its aqueous suspension immediately filtered, or it was allowed to stand as a suspension for 2 hours before filtration. In addition, the relative amount of virus filtrable from suspensions of large and small particles was studied. Virus particles of three sizes were obtained by winnowing, as follows:—A glass tube, 1.5 m long and 2.8 cm inside diameter, was fixed vertically. To the bottom was attached a glass vessel containing virus powder through which a stream of air was forced, blowing the material into the vertical tubing. The top of the apparatus was fitted with an air escape and a trap for the collection of the finest particles. After removing the latter, the remaining powder was divided into coarse and medium sized particles by increasing the air current. In the three tests just described 190 plants were inoculated to determine virus potency.

All filtrations were made through Berkefeld "N" candles. Plants were inoculated by the method described by McKinney,[4] usually with a series of tenfold dilutions beginning with 1 per cent.

RESULTS AND DISCUSSION

With the method of pulverizing employed, partial or complete inactivation of the virus in the dilutions used occurred in 12 hours. The degree of inactivation varied with the time and intensity of pulverization. The following table shows the results of the inoculation of 18 plants with material obtained in two typical experiments.

		5 min.	1 hr.	2 hrs.	3 hrs.	4 hrs.	6 hrs.	12 hrs.
Test 1	No of positives of 18 plants	15	10	5	No test	0	0	0
Test 2		11	No test	No test	14	No test	8	2

While the procedure of pulverization did not raise the temperature of the container to a perceptible degree, nevertheless the development of local heat should be considered, for the heat may destroy the virus or act as an oxidizing agent. In this connection it is of interest that the plant tissue turns from green almost to white after 12 hours' aerobic comminution but from green to still darker green after similar anaerobic procedure. An attempt was made to minimize any local heat by packing the container in carbon dioxide snow. But in this instance no change in the degree of inactivation was observed.

It was thought that if inactivation took place under aerobic and not under anaerobic conditions, it might be ascribed to oxidation. But the inactivation of the virus took place more quickly under anaerobic conditions. For example, in two typical tests, 30 of 32 plants inoculated with material before comminution were positive and 20 of 32 plants injected with virus pulverized for 12 hours under aerobic conditions showed mosaic disease, whereas none of 29 plants inoculated with material pulverized anaerobically for 12 hours was affected. Perhaps under lowered oxygen tension the virus is reduced at the expense of tissue oxidation. However this may be, virus previously comminuted anaerobically was not reactivated when pulverized later aerobically.

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[1] B. M. Duggar and J. K. Armstrong, *Ann. Missouri Botanical Garden*, 10, 191, 1923.

[2] Similar in size and shape to centrifuge bottle No. 3139-A of the Arthur H. Thomas catalogue, and made by the Corning Glass Works, Corning, New York.

[3] L. J. Boëz, *J. Bact.*, 13, 227, 1927.

[4] H. H. McKinney, *J. Agric. Res.*, 35, 13, 1927.

The possibility of the loss of infectivity being due to adsorption of virus by powdered tissue must be considered. In the three adsorption experiments above described, 75 per cent. of 104 plants were positive after the inoculation of comminuted virus mixed with finely pulverized normal plant tissue, as compared with 77 per cent. of 86 control plants injected with virus powder alone. It should be pointed out, however, that under the conditions of the experiments forceful impact of particles as in the ordinary procedure did not occur. In the winnowing experiment, in which particles of three degrees of magnitude were obtained, no differences in virus potency were found. It follows that there was no greater tendency of the smaller particles to adsorb virus. Adsorption, if it occurs, is therefore probably not the main cause of the inactivation.

Conclusion

Tomato mosaic virus loses its infectivity when tissues containing it are comminuted by the method described.

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STUDIES ON THE ETIOLOGY OF POLIOMYELITIS: ISOLATION AND CULTIVATION OF AN ORGANISM AND TRANSMISSION OF THE DISEASE IN MONKEYS

Poliomyelitis (infantile paralysis) has been experimentally reproduced in monkeys with the third, fourth, sixth, eighth, ninth, eleventh and thirteenth "generations" of an organism isolated and grown artificially from the nervous tissues of monkeys known to be infected with the virus responsible for the disease. The organism was cultivated from Berkefeld filtrates prepared from such poliomyelitic materials. It is extremely small, measuring approximately 1/500,000 to 1/250,000 of an inch, and has been grown in a special food medium containing minced sheep brain. In the thirteenth subplant the dilution of the original inoculum cultivated was approximately 2×10^{-37}.

Certain requirements must be met in order to show that a microbe may have something to do with a disease. These are known as the Koch postulates, and demand first, the isolation of the organism in pure culture from the animal harboring the disease; second, the reproduction of the identical disease by the inoculation of these germs into healthy susceptible animals; third, the recovery from such experimentally infected animals of the identical original microbe; fourth, the reproduction once again of the typical disease with these "recaptured" germs.

All these conditions have been fulfilled by the organism that has been reported and described. The disease, furthermore, has been carried on through a series of monkeys in which the infection was produced by means of Berkefeld filtrates or suspensions of nervous tissues prepared from the animals originally inoculated with the microbe. From such "passage" monkeys it was also possible to recover the same germ.

The experiments proved that the "recaptured" virus had the same properties of the original substance known to cause poliomyelitis. These characteristics are its ability to pass through fine filters, to induce typical infection with the characteristic clinical and pathological changes, and lastly, to appear again in a pure culture identical with the original organism.

The most recent studies in our laboratory have shown that the blood serum from a series of monkeys infected with the organism and now convalescent from poliomyelitis, possessed the power to neutralize and combat the ordinary filterable virus of infantile paralysis. This has been demonstrated as follows: Mixtures of a minute amount of each serum with a large amount of active virus were inoculated into the brain of a series of healthy monkeys. These animals did not develop the disease whereas those that received the virus alone succumbed to poliomyelitic infection. To verify the fact further, the animals that furnished these protective serums were likewise inoculated into the brain with active virus alone. These animals resisted the inoculation whereas another set of monkeys that had never had the disease became paralyzed in the typical manner. Thus the convalescent monkeys proved to be immune to the infection and showed immune substances in the blood serum capable of neutralizing the virus of the disease. The resistance to poliomyelitis, therefore, was the same as that which results when the animal recovers from an infection caused by the ordinary poliomyelitis virus filtrate. These observations suggest that the microorganism behaved exactly like the virus.

It must be understood that there are certain established methods for the experimental proof of the microbial cause of any disease. These methods have been followed and have fulfilled desired requirements designed to show the relationship of a microbe to the disease in question. That hidden factors may still exist is admitted frankly, only because our present methods of attack upon a problem of this type may be inadequate for bringing to light such concealed factors. However, only those facts which have come out of this research have been utilized in drawing justifiable conclusions warranted by the facts, and these must be based upon the only available methods of approach that are known at the present time.

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THE RELATIONSHIP BETWEEN THE WATER CONTENT AND OXYGEN CONSUMPTION OF THE ORGANISM

THE rôle of water as a medium of reaction within the cell has not yet been fully comprehended. This is not surprising in view of the fact that the conditions that control the distribution of water from free to bound states have been elusive. At the suggestion of Dr. J. W. Buchanan, the experiments[1] summarized here were undertaken as an attempt to disclose a possible relation between free water, *i.e.*, water that may be added or abstracted by changed osmotic conditions, and the rate of oxidative reactions in the organism. Such a relation would rest fundamentally on the law of mass action, that is, the relative concentrations of oxidizable substrates and oxidative enzymes.

Previous observations are apparently conflicting. Certain investigators[2] have measured increases in respiratory metabolism in dehydrated tissues, while, conversely, others[3] have showed water uptake to be associated with decreased metabolism. On the other hand, there is some evidence that the opposite relationship may hold true.[4]

The writer used *Planaria dorotocephala* and early embryos of *Amblystoma punctatum*. Water content was controlled by immersing the animals in solutions of differing osmotic pressures, and oxygen consumption was measured in two ways, with the Winkler method and by a microrespirometer.

As far as possible the same individuals were tested under different conditions over three-hour periods. Each period in a test solution was preceded by one in tap water to establish a norm and a control for successive measurements.

The averaged results of the Winkler tests are grouped into the following table.

PER CENT. CHANGES IN RATE OF OXYGEN CONSUMPTION

	Planaria dorotocephala	*Amblystoma punctatum*
Distilled water	− 54	− 21
Ringer's solution	+ 43	+ 62

These observations were checked by numerous experiments with the respirometer. It was found excellent for use with amphibian embryos but unsatisfactory for Planaria due to necessary shaking which prevented the animals from coming to rest. In the case of the former dehydration yielded an average increase of 39 per cent. above the normal in tap water, while treatment with distilled water lowered the rate of oxygen consumption about 42 per cent.

Early *Amblystoma* embryos, when immersed in distilled water, half tap- half distilled water, half Ringer's, and full Ringer's, reached and maintained their maximum swelling or shrinkage within sixty minutes, while planarians show water content changes over a period of one half to six hours in Ringer's and one half to more than sixteen hours in distilled water.[3] Sections of animals so treated indicate that water changes are both inter- and intracellular. At present no rules generally applicable to all animals can be drawn.

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[1] The work was carried out at the Osborn Zoological Laboratory, Yale University.

[2] E. Kreps, Pfluger's Arch., 222, 215–233, 1929; G. T. Caldwell, *Physiol. Zool.*, IV, 2, 324–359, 1931; J. W. Buchanan, *Jour. Exp. Zool.*, 57, 3, 455–472, 1930.

[3] J. W. Buchanan, *Jour. Exp. Zool.*, 57, 2, 307–330, 1930; *Biol. Bul.* LX, 3, 309–326, 1931.

[4] L. C. Beadle, *Jour. Exp. Biol.*, VIII, 3, 211–227, 1931.

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SCIENCE

VOL. 75 FRIDAY, MAY 20, 1932 No. 1951

The Pioneering Process: DR. ISAIAH BOWMAN 521

Scientific Events:

The Zoological Society of London; Research Committees on the Section of Hydrology of the American Geophysical Union; The National Parks Association; The American Physical Society; The Sixth International Congress of Genetics; Appropriations for Grants-in-Aid by the National Research Council; The Medal Meeting of the Franklin Institute 528

Scientific Notes and News 531

Discussion:

Relations of Bioclimatics to the Other Sciences: DR. ANDREW D. HOPKINS. *Periglacial Phenomena in the Puget Sound Region:* HENRY M. EAKIN. *Meter in Composition:* THE REV. GEORGE W. LAY. *Academic Freedom in Spain:* DR. P. H. YANCEY. *Durable Films:* DR. C. WARD CRAMPTON 535

Special Articles:

The Deflection of Light in the Sun's Gravitational Field: ROBERT J. TRUMPLER. *Normal Tissues as a Possible Source of Inhibitor for Tumors:* DR. JAMES B. MURPHY and ERNEST STURM. *Meta-amino Para-hydroxy Phenyl Arsine Oxide as an Antisyphilitic Agent:* DR. ARTHUR L. TATUM and GARRETT A. COOPER. *Airplane Oiling to Control Mosquitoes:* PROFESSOR JOSEPH M. GINSBURG 538

The National Academy of Sciences:

Papers Presented at the Washington Meeting 543

Science News 8

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THE PIONEERING PROCESS[1]

By Dr. ISAIAH BOWMAN

DIRECTOR OF THE AMERICAN GEOGRAPHICAL SOCIETY OF NEW YORK

So long as men "looked for a sign" the way of life was easy to find. Pioneer colonists took what the land offered: "That with their miseries they opened a way to their new-lands." This was man the wayfarer and burden-bearer, not man the destiny-guider. At length science began to interpret the physical world round about—its amplitude or scale, its great variety of environments, its favored areas, the breeding grounds and the courses of the storms, the way of the currents in the sea, the natural food supplies, and finally the improvements that could be made here and there by inventions and by technical processes that grew out of the attempt to apply scientific discoveries to man's own well-being.

Locke held that "it is easier to believe than to be scientifically instructed." Even now, in the full morning of the scientific day, crude belief is the basis of most of our human acts and relationships—a hunch that a given law, condition, social or economic arrangement is better than some or any other. The "method of science," which means the experimental method, is good enough for all but the affairs of men. In a sense this has been fortunate, for civilization could scarcely have had a beginning if the law of demonstration had always held sway. What was first needed was a rough-hewn scheme and a faith-yielding people. As life got more complex it became more troublesome to think about and the effects of a given act harder to anticipate and to measure. Always men have sighed for the good old times, meaning the simpler times. Even among "scientific" men, the *curiosi*, the individual is as apt as the rest of mankind to be credulous and faith-giving outside his own bailiwick. Johnson's Dictionary of 1799 defined the word "scientifick" as "producing certainty." How we wish it did! After observing the part of science in the social forces of our day we are tempted to define it as "producing uncertainty." Strange mixed harvests of thinking and guesswork and faith go into the making of civilization!

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[1] Address delivered at the annual banquet of the Society of the Sigma Xi, Yale University, March 19, 1932.

In creating the elements of civilization it was discovered that the greatest single fact about humanity—despite all its fears and hesitations—is its willingness to advance across the border of experience: "and yet men strive to find a way." Every generation supplies its quota of men who question and venture and who are not dismayed by the failures and fears of others. The world is on a hinge and they want to swing it. Venturing mankind had to learn, however, that social evolution progressed only so fast as man could discover and control extra-human energies and apply them socially without smashing society in the process. Great as was the effect upon trade of the ocean-going ship, its greatest effect was in making possible new or greatly changed social and political systems through economic betterment that depended upon swifter and cheaper trade by sea. A full-rigged ship under sail develops at least 500 horse power, or 6,000 man power. These figures were of tremendous importance when they first became applicable, because the development of such unheard-of power required but a handful of men: two men can steer a full-rigged ship and twelve men furl her largest mainsail. Kingdoms and empires and economic and social systems came to be built upon this new form of extra-human energy, the ship.

The magic of science, its ameliorating influences upon life, the thousand and one conveniences which it has supplied—these are to-day but the elementary aspects of the situation. Science now presents a more serious aspect and is bound to more fateful consequences. In our time we have seen it as a sort of Trojan horse out of which have come arms and armaments and poison gas, and new opportunities to enslave and prey upon and destroy society. It was contended by Bagehot that it is the "highest genius of government to evoke new power." The power that he had in mind was the power to shape the economic and political systems of the day, the power really to guide the destiny of a nation. How tragic that the evocation of that power has lagged so far behind material things and powers that have profoundly changed human relations.

It is from such a standpoint that we may perhaps most advantageously look at those thrusts of culture into the undeveloped lands by a process we call pioneering. These thrusts have been largely haphazard in the past because our knowledge of the new environment of the frontier was both unsystematic and incomplete. The land-tilling pioneer had to be his own scientist. It was the "look" of the soil and the native vegetation upon which he largely depended. The pioneer has been continually gambling on the earth, at times confident that she would return a harvest, yet again and again disappointed in her, cursing her and then returning to gamble again. That is why the pioneer has been called a "luck-hunter." The trick was to learn "when to labor and when to wait without losing courage."

The forward thrust of population into new land means not merely a movement of people. It means also the extension of a system of agriculture as well as systems of economics and of social organization. The earth can not be viewed abstractly by the colonizer. A piece of land is not merely something to be judged according to its capacity of producing a given crop. The system of tillage that may be employed comes to have as much to do with the result as the rainfall. Great distance from market may prevent the exploitation of even the richest soil. The remoteness of a given region may make it impossible to maintain contact with neighbors and to participate in community life. These we call matters of "social density" and "economic density," and there are limits of toleration to both. At least this is true for the greater number of people, though account must also be taken of the pioneer of the Voortrekker type whose "neighbors' smoke shall vex his eyes" and whose chief purpose between birth and death seems to be to increase the distance between himself and a railroad.

Civilization is like a city—it is always being rebuilt. Always "in the center shall come another word," as one Maya glyph is rendered. This means that the outward thrust of civilization constantly changes its objectives, its degree of employment of the instruments of power and even its spirit. The history of pioneering is a history of mankind advancing into new territory by adapting instruments and attitudes and systems. If the pioneer of to-day expects success he must be responsive to world economic demands, and this requires him to have a definite production technique applied in a specific geographical environment whose possibilities have to be discovered one by one through experimentation. This has always been true to some extent. It is almost universally true of the remaining pioneer lands of the world because those lands are not always of the best. Most of them are marginal lands where the climatic extremes have an exceptionally wide swing, where the soils are notably different from those in regions that have "normal" climatic conditions. They lie on the colder, the hotter, the drier, or the more distant borders of the areas of denser settlement. On the one hand they are bordered by belts of denser farming population, on the other hand by grasslands requiring an economy of their own and occupied by a scattered population.

It would be relatively simple for man to occupy the marginal lands in which modern pioneering goes forward if the advance were made by twos and threes and no thought given to the standard of living. As a matter of fact, the advance is made by communities, by groups of people, by colonies, or, as in Manchuria, by a swarm of humanity. Among all these there are two types, broadly speaking: first, those who go from machine-equipped communities with high standards of living; and, second, those who go from a land of hoe culture and tiny farms where there is small command over instruments of power. To the latter class pioneering is not in a high degree experimental, because the only question that is asked is whether human labor applied to the soil through a hoe or a plow will raise a crop that will sustain life and provide a small margin for purchases at a local trading center. To the former type—the machine-equipped pioneer—the question of a mere living is but one of a number of questions that confront him. He has in mind a standard of living. He does not merely live; he will try to live in a certain way. He looks not merely at the land under his feet and at the sky above; he looks back also to the communities which he left behind and he sees that government does things for communities. It provides them with railways and telegraph lines, with quick mail service, with schools and with marketing facilities. If not directly, at least it makes possible their doing or permits them to be done or encourages them to be done.

Nor do these things always depend upon the initiative or the demand of the pioneer. Government itself takes a hand in the pioneering process, to encourage it, to persuade more people to live upon the land, to provide a broader basis for the industries of its cities by extending the acreages of farms and the number of farmers, by making life upon the frontier *attractive* to the immigrant. Thus, Argentina and Brazil have at times attracted European migrants by the offer of free seed, free agricultural implements, and land at a low price with easy terms of payment. Organizations exist to help the settler. In London there are the Oversea Settlement Department, the 1820 Settlers' Association and others. In places in southern Africa the settler is received for a year upon an established farm as an apprentice to learn how to till the ground; in fact, to learn the whole business and technique of farming under local conditions. Government has taken a hand in group settlement in Western Australia, assisted migrants with free steamship fares, assured them a weekly wage, and offered them newly cleared land equipped with farm buildings at a reasonable price. Canada has maintained an alert attitude toward the streams of settlers that have flowed through her eastern ports and has sought to put them upon the land under conditions that would guarantee permanent occupation of new territory and types of community life that would make the new settler a part of Canada in a reasonably short time, a process known as Canadianization.

Technical studies have sometimes gone ahead of the pioneer, but more generally these have been of the reconnaissance type. The occupation of the new land has been experimental by the farmer himself. Here willingness plays a large part—willingness to experiment. In general, the city dweller wants his system set up for him. The farmer who has come from a given community to the border is more willing to try out a new scheme, accept for the time being a lower standard of living, and show some confidence in the future growth of the region. There is a great deal of pushing forward on all frontiers by the slow method of occupying land that is "just over there," with but little change in the culture system. The tillage is the same, the machinery required is the same, the crops are the same as those already known. Or, if changes are required, they are moderate. The old friends are near by and accessible. Such a movement asks no questions of the statistician or the scientist. It relies upon its own judgment. The men involved in it would scarcely look at a soil map. And it certainly scans no far horizon for opportunities that are or may be better than those near at hand. This type of advance is taking place wherever pioneer lands are available and in spite of a world-wide depression in agriculture, difficulties of transport, and apparently uneconomic distances to market.

Since the world war both science and government have concerned themselves very much more than before with questions arising out of the flow of population from country to country. The first general conclusion in the countries of the new world was that the flow from Europe should be greatly diminished. The streams of population were thus backed up at their sources, with a certain amount of international ill-will as a consequence. The damming process permitted the governments of the newer countries of the West to examine their economic and social structures and to determine how far population need be admitted at all or, when admitted, what disposition of it could safely be made. It seemed almost axiomatic that population could be admitted at almost any given rate so long as it was placed upon the land, for increasing acreages of tilled land were taken to mean increasing national strength. No one looked forward to a day of pronounced agricultural overproduction the world around. No one had anticipated so great a disproportion between food production and food consumption.

The occupation of new land thus became the business of government, and the policies in relation thereto came to be intimately connected with national immigration policies. More and more we call our earth and its peoples "a world without frontiers," but this has reference to the flow of culture chiefly. As a matter of fact, we are more conscious than ever of political frontiers, and as for the pioneering border, that is now a matter of public and international concern. The "border" is not merely a fringe where people can be left to take care of themselves. We must incessantly strive if possible to foresee the consequences that will or may follow upon the adoption of any given policy. It is stupid to see only the facts that lie obviously before us. Science tries to be not merely responsive to events which have already happened but "creative of events which are about to happen."

The population problem becomes even more complex when we recall the extent to which land has been abandoned throughout our own country, communities left to rust out, and land to revert to perplexed state governments. We have discovered that it is unintelligent to grow everything that can be grown in a given place. More and more, agriculture is differentiating the earth. A thing tends to be grown in the place where it can be grown best, that is, most economically. There is surely no need of new farms unless they can produce more cheaply than the farms that are now in use.

Definitions have but a minor part in the process, in spite of the need for the application of principles embodied in definitions. The very basis of the state, said Confucius, was in "getting the words right"; but there is a higher law—making the words live. The American traveling in Europe has need for this sustaining truth as he takes his morning coffee, for the custom in that land of unhappy breakfasts is to boil and boil and boil, and so long as the grounds discolor the water the discolored water is coffee—by definition! It is not mere definition or technique but the living edge of experience that is required upon the border of land occupation. New communities have a noteworthy flexibility of spirit, a power of adaptation of social forms to the requirements of new situations. Whatever the physical likenesses of pioneer regions, each has its unique social and economic qualities, its distinctive peoples, its own rate of flow of life in new channels.

To one accustomed to think that pioneering is ended in the United States these may appear to be remote questions applicable to Siberia and Australia and the Canadian Northwest, but having little significance in our own land. This position would seem to be fortified by the declaration of our Bureau of the Census in 1890 that "the unsettled area has been so broken into by isolated bodies of settlement that there can hardly be said to be a frontier line." In consequence, the extent of the unsettled area and the line that marked the border of advancing settlement were no longer emphasized in the census reports, which led later commentators to think that frontier conditions had passed and that the years immediately preceding 1890 marked the end of pioneering.

There are two important corrections to be applied to this simple concept. In the first place, the line between settled and unsettled country was drawn between population densities of two to the square mile and less than two, when as a matter of fact there are large areas of permanently settled western country that have less than two to the square mile, if (like the census of 1890) we take counties and smaller civil divisions as units and average the population. The second correction is still more important. The removal of a line from the map merely because that line has ceased to advance into unsettled country does not mark the end of pioneering. For pioneering is a process of experimentation, not merely an advance, and so long as the experimentation continues so long do pioneering conditions persist. I was first made aware of the existence and significance of long-continued frontier conditions while engaged in field studies in South America in 1907, in the course of the first Yale South American expedition. Again in 1913 I visited some of the oldest towns in South America on both the eastern and the western borders of the Andes in Argentina and Chile. Among them are Salta and Copiadó and the then isolated town of San Pedro de Atacama in Chile. In the frontier communities tributary to these towns one could still find many characteristics of frontier living. Here was what might be called a crystallized frontier type of life.

The same process of crystallization has taken place in our "zones of experimentation" in the Far West. On every hand one is made aware that he is on the border of the tilled land, not within the core. In core areas the rainfall may vary considerably and crops may vary accordingly. But at least there is some crop. By contrast the border of the tilled land is everywhere characterized by climatic extremes. These extremes do not mean merely a change in the output of grain and other products: they may mean a complete failure to produce anything at all from the ground. The problem of occupation of such areas is therefore expressed not merely by saying that there will be some years in which there is little or no crop and other years in which there will be abundant crops—perhaps sufficiently abundant to enable the farmer to accumulate reserves that will tide him over the dry years.[3] No, the problem is much more complicated than that because the moment there is a technological improvement in the methods or the machinery of farming there may be a very great change for the better or for the worse in the economic condition of the farmers in a given zone of experiment. That is a first possibility. A second possibility is that world production will change very greatly—now it will be high and again it may be very low. According as it varies it will affect the market price. This means, further, that farming in the zone of experimentation may be affected by world market prices as profoundly as by either years of abundant rainfall or years of drought. Lastly, there is a variation in rainfall that may be combined one way or another with the two variations noted above.

All this means that we have a permanent zone of experimentation along the border of the tilled land and that population is still advancing and retreating in local areas and still experimenting with the specific qualities of their land and their community and market possibilities. They are looking for new tools and new knowledge that will enable them to possess the land more securely. They are still inquiring how far it is profitable to advance into new climatic regions or how far they have already exceeded the limits of permanently successful occupation. Our successive land laws have recognized the need for units of land of varying size, subregion by subregion, but the application of the law has been very rough and needs to be refined on the basis of land classification studies still in progress. Insurance against extremes of climate may be desirable in the future, but what insurance can there be against something equally important, the wide fluctuation of the market price?

These are but indications of the categories of inquiry and fact in which the geographer is interested in his intensive study of the zone of experimentation called "the pioneer fringe." Economic, historical and sociological problems are also involved. Where earlier students saw the line of pioneering halted and a condition made static, the geographer sees a continuing dynamic. The frontier type of living is in a sense a permanent feature of the life of our western border country. Here the population must constantly experiment, constantly gamble on climate and market price if the land is to be occupied. The man who is unwilling to guess that the rainfall will be sufficient for a crop will never sow his seed and take his chances with rainfall or, rather, with drought. The process of adjustment is endless.

We can not say merely, "Withdraw farmers from the marginal lands and let grazing become the permanent form of occupation." There is no such thing as a "permanent" type of land use on our climatic borders. Moreover, the whole of society and economics is changing constantly. So, too, will the use of the land, and, so long as periods of wet years come on the dry borders and periods of frostless and protracted growing seasons on the cold borders, so long will settlers try their luck again and again, hazard their living on their guess that a crop can be raised, and challenge science to forecast the extremes of climate with which they gamble.

In a wider survey of pioneer lands in other continents we become aware of further complexities in the pioneering process that grow out of differences of race and system. Twenty million Chinese have gathered in Manchuria, first pushed out of the crowded regions farther south, especially Shantung, and later attracted to the fertile acres of the pioneer fringe farther north by the higher standard of living that they were able to win and by the establishment of communities that restored to them to a measurable degree the life they had left behind. Some change in dietary habits had also to be made and new methods learned of raising crops under unaccustomed climatic conditions. At last upon land that was long a "far north" to the Chinese there was developed a vast new political province served by a network of rails, "the civilizing rails," to use Jefferson's phrase. A broad, thinly peopled belt of frontier territory was changed to a field of political strife. A distant border has become a focus of intense international rivalry.

Southern Africa presents a wholly different group of problems. Here the pioneers have come among large native populations as masters who believe themselves capable of exercising power over both white and black and holding the scales of justice evenly at the same time. After the occupation of the southern coastal girdle of more accessible and better-favored land, white occupation spread northward following in recent years interior uplands upon whose summits and about whose borders the white man found it tolerable to live and work despite increasing nearness to the equator. The land was endowed in a number of places with mineral deposits of exceptional richness and value, with the consequence that railways could be supported virtually by mines alone. Railways thus became agents of pioneering, forerunners of land settlement. Plantations came into being on both sides of every railway line. Lacking the mine-railway combination land settlement would have been slowed down or halted altogether because the soils of southern Africa are naturally infertile, "desperately poor" in organic matter. Phosphorus is generally lacking. There is also a deficiency and high variability of rainfall over most of the territory. Climatic instability tends to retard settlement and the growth of white population. When there is a swing of rainfall from a wet to a dry phase the effects are not local but widespread, and on the borders of settlement they have again and again been devastating.

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[3] A two-year supply of forage for farm animals is commonly kept "in sight" in the western part of the High Plains of eastern New Mexico ("The Pioneer Fringe," published by the American Geographical Society of New York, 1931, p. 118. In this book and in a companion publication entitled "Pioneer Settlement" are a large number of maps showing the world's remaining pioneer lands).

Even now the principal crops of the Union are extremely low in average yield, maize being about one third of a crop, judged by American standards. More intensive and diversified cultivation in the favored areas and a greater differentiation of land use has been the result. The country has tended to break up into better demarcated regions with ranching and transitional farming coming in upon the poorer lands. In the high veld of the southern and southeastern Transvaal, for example, the vast farms of an earlier day are no longer the rule. Two hundred to four hundred acre tracts are now common. In the northwestern part of the high veld the rainfall is less reliable and land values are low. Individual holdings are therefore larger—up to two thousand acres. In the Limpopo Valley, still farther north, acreages run as high as ten thousand per individual holding. Always in the direction of uncertainty of rainfall the size of the farms tends to be larger and occupation more unstable. This instability makes its special appeal to legislators, who number among them a large proportion of farmers; and the consequence is possibly "an over-expenditure of state funds to relieve the hardships of the sufferers."

A culture system based upon the plantation has given pioneering in South America a distinctive stamp. In some places the native population was exploited under the institution known as peonage, a mild form of slavery. Ownership of property and land was reserved for the whites, who were from the beginning a privileged class. One effect of the plantation system and an available supply of native labor was that it brought lands under cultivation which would otherwise have been too distant to exploit economically, and it thus provided government with larger and larger acreages of taxable property. Mineral and rubber concessions were found to be profitable devices to secure roads and bridges to outlying districts. Thus the chain of Andean states running from Argentina to Panama contrived to bind their scattered agricultural lands into something like units and to hold isolated population groups together in loosely organized political systems.

The second half of the nineteenth century, the period in which most of the railroads were built, witnessed, curiously enough, a drawing-in of the limits of settlement in many remarkable instances, as men became tied to the new economic system of which the railroad was the symbol and in which time came to be more and more important. The speed of transportation now became an inescapable part of the process of moving goods and men. The United States has no class upon whose shoulders can be dropped so heavy a load as that which is dropped by the South American upon the lowest ranks of his society. He is intent upon maintaining the privileges and luxuries of a class: all is well if these privileges and luxuries are being enjoyed; all is wrong if they are taken away, no matter what the reason may be. In unbroken sequence the concepts that so long ruled Iberian life may be traced through the colonial period and the period of liberation in South America down to our own time.

The plantation system in South America persists in some places because it is economically best for all concerned, while in other places it is a device employed by the landowners for maintaining an essentially aristocratic system based upon land. In cereal-growing Argentina, large landholdings became the rule when Argentina was primarily a pastoral country; they have persisted through the change into a cereal-growing system in which pastoral interests still bulk large. The large landowner really doesn't want to give the small landowner a chance. He wants to maintain his system as he found it. "Agriculture has here become the handmaid of stock raising." Fully one half the grain exported from the republic is an incident to cattle raising. Seeing that his once cheap (and in places worthless) land has increased in value and made a fortune for him, the owner has made up his mind not to part with any more of it. Says Jefferson, "He could get a lot of money for his land if he sold it, but what should he do with the money? . . . He might lose it; and wasn't the value of the land increasing every day? Better keep the land and let the gringo [foreigner, *i.e.* European immigrant] go on working for him."[3]

Coupled with this state of things is the feeling that only members of the upper class are intelligent and responsible. In their view they own the land and govern the community in quite a proper sense. The peon has a station in life akin to that of the peasant in Europe, and the educated Argentine knows the culture and economic systems of Europe better by far than he knows the development of the really democratic systems of the New World that he thinks himself a part of. Little wonder, under such a system, that not all the good tillable land is by any means yet occupied. To the untilled acres must be added the economic loss sustained by a superficial cropping of the land.

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[3] Mark Jefferson: Peopling the Argentine Pampas, *Amer. Geogr. Soc. Research Series, No. 16*, New York, 1926, pp. 168–169.

In the Frontera of Chile we are witnessing to-day the last successful large-scale occupation of new land in that country. The patronage of the government has been extended to new settlers, who in past years have included both Chileans and Germans. Government even went so far as to forgive "obligations that turned out to be unreasonable." This humane attitude may be called "enlightened selfishness," for in the provinces farther north the point of saturation of population density has been approached, and government is obliged to turn to the pioneer zone of southern Chile and to the development of industries based on mineral deposits, enact social legislation of an advanced type, and develop something like a balanced agrarian program.

Where the line of settlement ends in Chile will depend upon the value of the products that the settler can get from the soil and upon the limits of human tolerability with respect to rain and its consequences in muddy roads and shortened seasons of labor. The experience of hardy settlers on many frontiers shows that the limits of tolerability can not be forecast. The Frontera is therefore a region of experimentation in a broad sense. Trees have to be felled, rain endured, and poor communications as well, and specialized production practiced. The environment is new and strange to the colonizing Chilean; and it can hardly appear as the best of earth to the German or French or Swiss immigrant. Government will improve some of the conditions, no doubt, as it has done in the past.

Cast in different form are the settlement problems of the eastern Andean valleys all the way from Venezuela and Colombia, on the north, southward along or near the Andean border, down through Bolivia and Argentina to the Strait of Magellan. On the north are tropical valleys far removed from the highland centers of population in the sense that steep and long grades must be overcome to get products out; and separated on the east by broad stretches of lowland, densely forested, that run to the Atlantic. In the Gran Chaco of Bolivia and Paraguay settlement has pressed forward far enough to bring this once useless land within the international framework. For centuries it was empty land beyond the outposts of settlement; to-day it is the scene of armed conflict between Paraguay and Bolivia and is involved in one of the major international boundary disputes of South America—all because of the value of the Paraguay River as a commercial outlet and the undeveloped resources of timber and pasture that have attracted the attention of political and commercial leaders. Northern Patagonia has for several decades been the scene of increasing colonization by farmers and herdsmen; and in scattered situations in central and southern Patagonia grazing interests have everywhere sought out the better sites.

Without attempting to describe the remaining pioneer lands, we may take a look, in closing, at a professional aspect of the problem of pioneering that may not be without interest to you. It will be clear from a review of the concepts that we have dealt with that "a science of settlement" can not be developed by a single discipline. The moment institutions are taken into account, the moment we challenge a given system, the moment we deal with the actual complexities of the problems of present-day life, we are bound to consult widely. Of necessity the individual is really expert only in a narrow field. It is time that restricts him, not narrowness of spirit or limited outlook. Time is required for that indispensable mastery of at least one technique, or several techniques, that is necessary if one is to make progress in original investigation. But the moment one leaves an area of special expertness and enters a broad field of inquiry like pioneer settlement one must bring experts together. For when the individual attempts to cross over into an unfamiliar field he is apt to drop back to the elementary generalities or concepts of the textbooks. Here it is that cooperation with his fellows enables him to avoid the worst consequences of his deficiency. By this means there is mutual education at a rapid pace of experts who have ideas and techniques, variant and unfamiliar (as between different groups), that it is sought to apply to a problem of common interest.

Cooperative research is not a mere trading of ideas, not just a speeding-up of output; nor is it a new form of magic. It definitely is a means of rendering neutral and harmless the tendency to certainty, the too great simplification of ideas, and enslavement to accepted methods. Through the medium of a common problem it locates the living edge of experience and opinion in related fields. The first results of modern science were considered so beautifully demonstrative that, backed by forensic power, they were made to seem final and complete. The tendency may be offset by getting away from the rules and seeing realities naïvely as well as through the "principles" that embody the generalizations of a single science.

A practical test of the method is now being made by a group of Canadian scholars who have formed a "Canadian Pioneer Problems Committee," working under the auspices of the American Geographical Society and supported on the one hand by the Social Science Research Council and on the other by individuals, institutions, and bureaus of government in Canada. Two field seasons have been occupied in gathering information first hand according to a well-defined but flexible scheme of investigation set up in the beginning. The successive annual reports of the committee have demonstrated the wisdom of the method, and within a year or two there will appear a number of volumes of results that can not fail to be of importance to Canada as a nation as well as to other countries having large areas of marginal lands which are or will soon be in process of development.

SCIENTIFIC EVENTS

THE ZOOLOGICAL SOCIETY OF LONDON

ACCORDING to the annual report of the Zoological Society of London, as reported in the London *Times*, the assets of the society amount to £177,708, a decrease of £493 on the corresponding figures for last year, but these do not include the capital of the De Arroyave Trust Fund, the chief item in which is a holding in consolidated 2½ per cent. stock of £123,889. The total income of the year was £141,525, an increase of over £7,000 on that of last year. The income from the Regent's Park Gardens was much less than in 1930, chiefly on account of the bad weather during the greater part of the season, but this was more than made up by the income from the new park at Whipsnade, opened for the first time last Whitsuntide. The total number of fellows decreased from 8,430 to 8,307, as the new fellows elected did not balance the number of deaths and resignations.

The gardens are again to be kept open until 11 P. M. on Thursday evenings from June 2 to August 25 inclusive, and the J. H. Squire Celeste Octet is to play during dinner. On Saturdays and Sundays from May 28 to August 28, inclusive, the band of the 65th (8th London) Field Brigade, Royal Artillery, will play in the afternoons. It is regarded as doubtful if the Thursday evening late openings actually cover the cost of the extra attendance and lighting, but they give an opportunity to many persons engaged during the day to see the collection.

Notwithstanding the bad weather, there were only 27 deaths among the animals from tuberculosis, the lowest since 1925, and of these only one was a monkey which had been 11 months in the gardens and had probably been affected before its arrival. Among the mammals bred and reared in the gardens were three kangaroos and wallabies, two opossums, three porcupines, three musquash, four agoutis, four coypus, a yak, bison, Mongolian wild horses, Grévy's zebra, sea-lion, lion, eland, black-buck, water-buck, nylghaie and lemur, four ibex, 10 wolves, four Barbary wild sheep, and six thar. Among the birds bred and reared the most notable successes were four Cape penguins, one macaw, one cockatiel, 20 parrakeets belonging to several species, and 138 budgerigars, including green, yellow and blue varieties. At Whipsnade one wombat, one llama, one yak, one red deer, one fallow deer, two nylghaie, two black-buck, two white red deer, two Chartley and five Highland cattle, and six wolves were bred and reared.

RESEARCH COMMITTEES OF THE SECTION OF HYDROLOGY OF THE AMERICAN GEOPHYSICAL UNION

THE Section of Hydrology of the American Geophysical Union has announced the organization of nine permanent research committees. This section is concerned with the study of the waters of the earth from the time they are precipitated upon the surface as rain or snow until they are returned to the atmosphere or are discharged into the ocean. Each committee is to make an annual survey of work in progress in the field of hydrology which it covers and to maintain contact with the workers in its field. Following is a list of the committees and chairmen, together with brief statements of the field to be covered by each committee:

Committee on Snow: J. E. Church, meteorologist, Nevada Agricultural Experiment Station, and adviser, Nevada Cooperative Snow Surveys, University of Nevada, Reno. The quantity and distribution of the snowfall, the methods of making snow surveys, the melting and evaporation of the snow and the relation of the snow to run-off and absorption.

Committee on Glaciers: F. E. Matthes, geologist, Geologic Branch, U. S. Geological Survey, Washington, D. C. The hydrology of existing glaciers, as distinguished from the work and products of ancient glaciers. The committee is to obtain and interpret systematic records of the advance and retreat of glaciers in the United States, including Alaska; also, related records of the movement of the ice, weather conditions and the discharge of water from the glaciers.

Committee on Evaporation: G. F. McEwen, oceanographer, Scripps Institution of Oceanography, University of California, La Jolla. The rate of evaporation from free-water surfaces, the effects of weather and other conditions that influence evaporation, and the methods of determining evaporation; also, the fluctuations of lakes and their causes.

Committee on Absorption and Transpiration: C. H.

Lee, consulting hydraulic engineer, San Francisco. The absorption of rain, snow and stream water into the earth and its penetration to the water table; the discharge of water by evaporation from the soil and by the transpiration of plants, and the effects of intake and discharge on the ground-water levels.

Committee on Run-off: L. K. Sherman, consulting engineer, Randolph-Perkins Co., Chicago. The quantities of water discharged by the streams and the fluctuations in the rates of discharge; also, the geographic, climatic and other conditions that influence the rate of discharge.

Committee on Physics of Soil Moisture: F. J. Veihmeyer, professor of irrigation investigations and practice, College of Agriculture, University of California, Davis. The molecular forces that control or influence the occurrence and movement of water in the interstices of the soil and rock formations, including the dynamics of soil moisture in land slides, mud-flows, subsidences and frost action.

Committee on Underground Water: D. G. Thompson, geologist, Water Resources Branch, U. S. Geological Survey, Washington, D. C. The occurrence, head and movement of the water in the zone of saturation.

Committee on Dynamics of Streams: L. G. Straub, professor of hydraulic engineering, University of Minnesota, Minneapolis. The laws of flow of water in rivers and smaller streams, the forces which the water exerts, the work which it does in erosion, transportation and deposition, and the relations between the streams and the channels that they occupy.

Committee on Chemistry of Natural Waters: C. S. Scofield, agriculturist in charge, Division of Western Irrigation Agriculture, U. S. Bureau of Plant Industry, Washington, D. C. The chemical composition and chemical work of the natural waters, both above and below the surface; also, the relation of the fresh water to the salt water, both above and below the surface.

THE NATIONAL PARKS ASSOCIATION

PLANS for rounding out and developing the nation's system of national parks were discussed at the annual meeting of the National Parks Association held at the Cosmos Club, Washington, D. C., on May 9. Presided over by Dr. Wallace W. Atwood, president of Clark University, this meeting was attended by many of the leaders in conservation who constitute the board of trustees of the association.

Dr. Ray Lyman Wilbur, Secretary of the Interior; Frederic C. Walcott, United States Senator from Connecticut; Dr. John C. Merriam, president of the Carnegie Institution of Washington; Horace M. Albright, director of the National Park Service, and Dr. Atwood were the principal speakers at the annual dinner which followed the afternoon business session, and was attended by more than 150 persons interested in the welfare of the national parks.

Describing the national parks and monuments as the most unique educational agencies in our national life, Dr. Wilbur praised the work of the association in furthering interest and support for the work of the National Park Service in developing and protecting these important educational and recreational areas and asked for its continued interest. Beauty in the national parks, both natural and man-made, was emphasized by Mr. Albright, director of the National Park Service, in an illustrated talk which included colored slides of beautiful scenes in the park system. Special interest was manifested in the pictures of Great Smoky Mountains National Park, the newest in the system, and the proposed Shenandoah Park in the Virginia Blue Ridge, the Everglades, which, if established, will be the only tropical park in the system, and Isle Royale, a beautiful Michigan island in Lake Superior. All these projects have been authorized by the Congress.

Preservation of wild life in our national parks was the subject of Senator Walcott's address. Dr. Merriam stressed the relation of the citizen to the national parks.

Since the establishment of the National Park Service as a bureau of the Department of the Interior in 1916, more than 25,000,000 persons have visited these parks and monuments. With one exception during the war the total number of visitors for each succeeding year has established a new record.

THE AMERICAN PHYSICAL SOCIETY

THE American Physical Society will hold its one hundred and seventy-ninth meeting at New Haven, Connecticut, on June 23, 24 and 25.

On Friday morning, June 24, there will be a program of invited papers on "X-rays and What They Suggest about Atomic and Other Structures." The speakers will be J. A. Bearden, J. W. M. DuMond, J. A. Gray and J. D. Hanawalt.

On Saturday morning there will be a program on "Plasticity" arranged by the division of applied mechanics of the American Society of Mechanical Engineers. Physicists have been invited to present papers on this subject from the point of view of physics and the Physical Society has been asked to join with the engineers in this session. The invited papers will be by F. Zwicky, Francis Bitter and R. L. Wegel.

Most of the contributed ten-minute papers will be read on Thursday morning. If necessary, a few may be carried over into Friday and Saturday mornings at times not conflicting with the hours of the symposia, or they may be presented before special conference groups. Conferences or round-table discussions on topics selected by request will be a feature of this meeting.

On Thursday afternoon, before a tea to be given out of doors or in the library, there will be an inspection of the Sterling Memorial Library, including special exhibits of books, maps, etc. The annual dinner of the society, held in conjunction with the American Society of Mechanical Engineers, will be followed by a complimentary performance of Milne's "The Perfect Alibi" by Yale students; there will also be a joint excursion starting late on Friday afternoon, including sea bathing, sports, a picnic supper and dancing. A limited number of reservations can be made on an observation train leaving New London at 5:40, standard time, on Friday to view the Yale-Harvard Boat Race.

THE SIXTH INTERNATIONAL CONGRESS OF GENETICS

THE following visitors to the Sixth International Congress of Genetics (Ithaca, New York, August 24–31, 1932) will be in the United States before or after the congress in order to deliver lectures at American universities and colleges.

Professor Kristine Bonnevie, University of Oslo.

Dr. R. A. Fisher, Rothamsted Experimental Station, Harpenden, England.

Professor R. Ruggles Gates, University of London.

Professor Richard Goldschmidt, Kaiser Wilhelm Institut für Biologie, Berlin-Dahlem.

Dr. J. B. S. Haldane, John Innes Horticultural Institution, Merton-London.

Dr. John Hammond, University of Cambridge, Cambridge.

Professor Julian Huxley, King's College, University of London.

Dr. H. Kihara, Kyoto Imperial University, Kyoto.

Dr. G. A. Levitsky, Institute of Applied Botany, Leningrad.

Professor Otto Mohr, University of Oslo.

Professor Hans Nachtsheim, Institut für Vererbungsforschung, Berlin-Dahlem.

Dr. M. Nawaschin, Moscow, U. S. S. R.

Dr. Curt Stern, Kaiser Wilhelm Institut für Biologie, Berlin-Dahlem.

Dr. N. Timofeeff-Ressovsky, Kaiser Wilhelm Institut für Hirnforschung, Berlin-Buch.

Professor N. Vaviloff, Institute of Applied Botany, Leningrad, U. S. S. R.

Dr. Paul Weiss, Vienna (now at Yale University).

Professor O. Winge, Royal Veterinary College, Copenhagen.

Professor M. J. Sirks, Agricultural College, Wageningen, Holland.

Dr. Alexander Serebrovsky, Timiriazev Institute, Moscow.

Other visitors who will probably come and who may be available for lectures are:

Dr. G. P. Frets, Municipal Hospital, Portugal, Rotterdam.

Dr. E. J. Gumbel, Heidelberg University, Heidelberg.

Dr. Ivar Johansson, Agricultural College, Uppsala.

Dr. G. D. Karpechenko, Institute of Botany, Detskoe-Seloe, Leningrad.

Dr. Klass Tjebbes, Sugar Beet Research Station, Landskrona, Sweden.

Many other geneticists will doubtless come from abroad, but definite statements can not be made yet. Information concerning dates and lecture subjects of visitors to the congress may be obtained from the Transportation Committee, care of L. C. Dunn, Columbia University.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT its April meeting the National Research Council's Committee on Grants-in-Aid made thirty-one grants for the support of individual research as follows, from eighty-one applications received:

Frank C. Jordan, director, Allegheny Observatory, Pittsburgh, Pennsylvania, the measurement and reduction of parallax plates; W. J. Luyten, head of the department of astronomy, University of Minnesota, the proper motions of the stars.

William D. Harkins, professor of chemistry, University of Chicago, a photographic study of the synthesis and disintegration of atoms; B. Smith Hopkins, professor of inorganic chemistry, University of Illinois, the properties of illinium; Karl Paul Link, professor of biochemistry, University of Wisconsin, the preparation of the naturally occurring hexuronic acids.

Ralph L. Belknap, assistant professor of geology, University of Michigan, the establishment and operation of a weather station on the west coast of Greenland; Margaret F. Boos, Bartlesville, Oklahoma, granites of the Silver Plume and Longs Peak Batholith, Colorado; Bruce L. Clark, associate professor of paleontology and historical geology, University of California, the Tertiary faunas and sections of the Southern part of the United States, and of selected localities in Europe; Charles E. Decker, professor of paleontology, University of Oklahoma, the large graptolite fauna of the Viola limestone; John M. Muir, Fort Worth, Texas, monograph on Mexican oilfields, and a general map of the surface geology of the Tampico embayment; A. Russell Oliver, fellow in geography, Clark University, land utilization in the Judith Basin, Montana.

Robert Chambers, professor of biology, New York University, the functions of the kidney; Paul F. Clark, professor of bacteriology, University of Wisconsin Medical School, the concentration of the virus of poliomyelitis; R. W. Gerard, associate professor of physiology, University of Chicago, the activity of nerve tissue and the central nervous system; Robert

Hegner, director, department of protozoology, School of Hygiene and Public Health, Johns Hopkins University, amebiasis in Panama; William C. Rose, professor of physiological chemistry, University of Illinois, the nutritive importance of the amino acids; Gordon H. Scott, associate professor of cytology, Washington University, the distribution of mineral salts in nerve cells and fibers.

Charles E. Burt, professor of biology, Southwestern College, the lizards of the United States and Canada; F. G. Gustafson, assistant professor of botany, University of Michigan, the anaerobic respiration of cacti; E. B. Hart, professor of agricultural chemistry, University of Wisconsin, the form and availability as food for animals of the iron in plant and animal tissues; LaDema M. Langdon, assistant professor of biology, Goucher College, the embryogeny of the Juglandaceae and Fagaceae; William J. Robbins, professor of botany, University of Missouri, determination of the conditions necessary for the continued cultivation of excised tissues; V. E. Shelford, professor of zoology, University of Illinois, the rodents of the Canadian tundra.

Leonard Carmichael, professor of psychology, Brown University, the cutaneous reflexogenous zones in the fetal guinea pig; Franklin Fearing, associate professor of psychology, Northwestern University, the functions of the non-acoustic labyrinth in birds; Laurence Foster, Stowe Teachers College, St. Louis, racial mixture between Negro, Indian and White stock in Maryland and Delaware; William Morgan, research associate, Yale University, personality studies of Navaho Indians; George M. Peterson, assistant professor of psychology, University of Denver, mechanisms of handedness in the rat; E. Sapir, department of social sciences, Yale University, songs of the Nitinat Indians; T. C. Schneirla, assistant professor of psychology, New York University, the behavior of the legionary ants of Panama of the sub-family Dorylinae; Calvin P. Stone, professor of psychology, Stanford University, mental characteristics of senile male albino rats.

GEORGE K. BURGESS,
Chairman

THE MEDAL MEETING OF THE FRANKLIN INSTITUTE

AT the annual medal meeting of the Franklin Institute on May 18 the following medals and awards were presented:

Certificate of Honorary Membership, George A. Hoadley, Sc.D., Swarthmore, Pennsylvania.

Certificate of Merit, Thomas Randolph Harrison, The Brown Instrument Company, Philadelphia.

The Longstreth Medal, Josua Gabriel Paulin, System Paulin Aktiebolag, Stockholm.

The Wetherill Medals, Halvor Olsen Hem, Toledo Scale Manufacturing Company, Ohio; Monroe Calculating Machine Company, Inc., Orange, New Jersey; Messrs. Baltzar Carl von Platen and Carl Georg Munters, Platen-Munters Refrigerating System, Stockholm; Frank Wenner, Bureau of Standards.

The Levy Medal, Wayne Buckles Nottingham, assistant professor of physics, Massachusetts Institute of Technology.

The Clark Medal, Philip Thornton Dashiell, United Gas Improvement Company, Philadelphia.

The Potts Medal, George Paget Thomson, professor of physics, Imperial College of Science and Technology, London.

The Cresson Medals, Percy Williams Bridgman, professor of physics, Harvard University; Charles LeGeyt Fortescue, Westinghouse Electric and Manufacturing Company, Pittsburgh; John Boswell Whitehead, dean, School of Engineering, the Johns Hopkins University.

The Franklin Medal and Certificate of Honorary Membership, Ambrose Swasey, The Warner and Swasey Company, Cleveland; Philipp Lenard, director, Radiological Institute, University of Heidelberg; received by the German Consul General in New York, Dr. O. C. Kiep.

Papers will be presented by the Franklin medalists: One entitled "Some Scientific Views" will be presented *in absentia* by Dr. Lenard and Dr. Swasey will speak on "Astronomers and Their Telescopes."

SCIENTIFIC NOTES AND NEWS

THE degree of honorary doctor of medicine has been conferred by the University of Amsterdam on Dr. Harvey Cushing, Moseley professor of surgery in the Harvard Medical School and surgeon-in-chief of the Peter Bent Brigham Hospital. Dr. Cushing plans to relinquish his work at the school and the hospital at the end of the academic year.

ON the occasion of the celebration of the commencement of the Michigan College of Mining and Technology at Houghton, the honorary degree of doctor of engineering will be conferred on Scott Turner, director of the U. S. Bureau of Mines, and on C. Harry Benedict, chief chemist of the Calumet and Hecla Mining Company. Mr. Turner will be the commencement speaker.

DR. TREAT B. JOHNSON, Sterling professor of chemistry at Yale University, and Dr. Herbert M. Evans, director of the Institute of Experimental Biology at the University of California, were among those elected to membership in the German Imperial Academy of Sciences at Halle at the meeting held on March 17 in commemoration of the centenary of the death of Goethe.

PROFESSOR ALBERT EINSTEIN is in England where he planned to spend three weeks at Christ Church College, Oxford. He delivered the lecture on the Rouse Ball Foundation at the University of Cambridge on May 6. The title of the lecture was "Die Theorie der Elektrizität im Rahmen der allgemeinen Relativitätstheorie." The doctorate of laws will be conferred on Dr. Einstein by the University of Glasgow. On account of engagements, however, he is unable to be present in June, but plans to attend the graduation ceremonies in 1933.

ELECTIONS of corresponding members of the Bavarian Academy of Sciences include: Dr. Ludwig Jost, professor of plant physiology at Heidelberg; Dr. Franz Kossmat, professor of geology at Leipzig, and Dr. Hans Stelle, professor of geology and paleontology at Göttingen.

M. M. VILLAT, professor at the Sorbonne, Paris, has been elected a member of the Paris Academy of Sciences in the section of mechanics to succeed the late G. Koenigs.

DR. CHARLES H. HERTY, of New York, chemical industrial consultant, received the medal of the American Institute of Chemists for "noteworthy and outstanding service to the science and profession of chemistry in America" at the annual meeting of the institute in New York City on May 7. Dr. Frederick E. Breithut, president of the institute, presided and made the presentation. Other speakers were: Joseph E. Ransdell, former U. S. Senator from Louisiana and now executive director of the conference board of the National Institute of Health; Dr. Marston T. Bogert, professor of organic chemistry at Columbia University, and Henry W. Jessup, lawyer. Former recipients of the annual medal include Andrew W. and Richard B. Mellon, for the establishment of the Mellon Institute for Industrial Research; the late George Eastman, and Mr. and Mrs. Francis P. Garvan, who established the Chemical Foundation.

JUAN DE LA CIERVA has been awarded the Guggenheim Gold Medal of 1932 for development of the theory and practice of the autogyro. This award was made by a board having eight members in the United States of America and seven foreign members. The foreign countries represented are Canada, England, France, Germany, Holland, Italy and Japan. The Daniel Guggenheim Medal was established in 1928 by the Daniel Guggenheim Fund for the Promotion of Aeronautics. It is sponsored jointly by the American Society of Mechanical Engineers and the Society of Automotive Engineers, each of whom appoint four members of the board of award. The president of the 1931-32 board, which awarded the medal to Mr. Cierva was Admiral H. I. Cone, commissioner of the U. S. Shipping Board. At the recent annual meeting, Captain Emory S. Land, of the Navy, was elected president for 1932-33, and Major E. E. Aldrin, vice-president. Medals have been awarded previously to Orville Wright, Ludwig Prandtl, Germany, and Frederick William Lanchester, England.

WILLIAM E. MOTT, retiring director of the College of Engineering of the Carnegie Institute of Technology, Pittsburgh, was the guest of honor at a dinner recently given by Dr. Thomas S. Baker, president of the institute.

FOUR senior members of the faculty of the Boston University School of Medicine—Dr. J. Emmons Briggs, professor of surgery; Dr. Alonzo G. Howard, professor of orthopedic surgery; Dr. Wesley T. Lee, professor of dermatology, and Dr. Clarence H. Dobson, assistant in medicine—and the staff of the Massachusetts Memorial Hospitals were honored with special recognition of their services to the two institutions, by more than a hundred of their colleagues at a testimonial dinner recently given in the University Club.

THE seventeenth annual meeting of the South Dakota Academy of Science was held at Yankton College, South Dakota, on May 6 and 7. The reading of papers by members occupied Friday afternoon and Saturday morning. After the academy dinner on Friday evening, Dr. S. C. Lind, director of the School of Chemistry of the University of Minnesota, delivered an address on "The Contributions of Radioactivity to Science." The following officers were elected for the year 1932-33: *President,* George Gilbertson, State College; *First Vice-president,* A. V. Arlton, Dakota Wesleyan University; *Second Vice-president,* Edw. P. Churchill, University of South Dakota; *Secretary-treasurer,* A. L. Haines, University of South Dakota.

DEAN WILLIAM F. LASBY, of the College of Dentistry at the University of Minnesota, was elected president of the American Association of Dental Schools at the recent meeting in Columbus, Ohio. Dean Lasby will take office in 1933.

ON the evening of May 10 was held the ninth annual meeting of the Virginia Chapter of Sigma Xi. Fifteen candidates were admitted to membership at this meeting. The annual address was delivered by Dr. Carl C. Speidel, professor of anatomy in the University of Virginia Medical School, on "The Growth and Repair of Living Nerves." The eighth annual award of the President and Visitors' Research Prize of one hundred dollars was made to Drs. A. F. Benton and T. A. White, of the department of chemistry for their paper on "Discontinuities in Adsorption Isotherms."

Dr. Henry E. Sigerist, director of the Institute of the History of Medicine at the University of Leipzig, has been appointed professor of the history of medicine in the Johns Hopkins University Medical School. He will take up this work on July 1. Dr. Sigerist will succeed Dr. William H. Welch, in whose name the chair was founded at the same time that the William H. Welch Medical Library was established.

Dr. Lee Maidment Hurd, professor of laryngology, and Dr. John McCloy, clinical professor of laryngology, both of New York University and Bellevue Hospital Medical College, have retired from active service and each will be named professor emeritus. Dr. Richard Atkins Davis, surgeon in charge of otolaryngology service at Bellevue Hospital, has been appointed professor of otolaryngology, effective September 1. Dr. Davis will head a new department of otolaryngology, which will be a combination of the departments of otology and laryngology.

Dr. John Stewart has resigned his position as dean of the Medical Faculty at Dalhousie University, Halifax, Nova Scotia.

The Electrochemical Society has recently awarded the Weston Fellowship in Electrochemistry for 1932–33 to Mr. Marlin E. Fogle, of Diagonal, Iowa. He will continue his studies at Columbia University under the direction of Dr. Colin G. Fink.

The department of chemistry of the College of Wooster, Ohio, announces the award to John Wellman of the Ralph H. McKee Prize. This prize, provided by Professor McKee, of Columbia University, an alumnus of Wooster, consists of a two-year membership in the American Chemical Society, and is awarded to that student who, at the end of the first semester of his junior year, has the highest standing in chemistry.

Among those giving courses in the summer session of the School of Medicine of the University of California will be Dr. J. W. Bridges, professor of abnormal psychology of the McGill University faculty of medicine, and Dr. Mark A. May, professor of educational psychology at Yale University.

Professor S. O. Mast, of the Johns Hopkins University, recently gave two lectures at Oberlin College; one on "Color in Organisms" and one on "Structure, Locomotion and Response in Amoeba." The lectures were given under the auspices of the department of zoology of Oberlin College.

Dr. Ralph Pemberton, associate professor of medicine at the University of Pennsylvania and chairman of the American Committee for the Control of Rheumatism, recently gave a clinic on arthritis at the Duke Hospital, and the following week Dr. Warren H. Lewis, of the department of embryology, Carnegie Institution of Washington, conducted a clinic on cancer.

The guest speaker at the annual meeting of the Toronto Biochemical Society, held jointly with the Toronto Chemical Association, in Toronto, was Dr. R. W. Gerard, of the department of physiology of the University of Chicago. Dr. Gerard spoke on "Energy Relations in Cell Oxidations."

According to *Nature* Lord Rutherford opened a discussion on "The Structure of Atomic Nuclei" at a recent meeting of the Royal Society. Dr. J. Chadwick, Dr. C. D. Ellis, Professor R. H. Fowler, Professor J. C. McLennan, Professor F. A. Lindemann and Mr. N. F. Mott were expected to take part.

Section O, Agriculture, of the American Association will meet in joint session with the northeastern section of the American Society of Agronomy at the summer meetings of the association in Syracuse, June 21, when they will participate in the program on land utilization. On June 22 the meeting will be held at Geneva, New York, consisting mainly of a visit to the laboratory at the New York Agricultural Experiment Station and to the fields, with a study of the fertilizer experiments, the canning crop investigations and the lysimeter experiments. The dinner and business meeting will be held in Geneva, and on June 23 the group will meet at Cornell University at Ithaca for an inspection of the investigational work of the department of agronomy, especially the field experimental work in agronomy and in plant breeding.

The twentieth annual meeting of the Eugenics Research Association will be held at the American Museum of Natural History, New York City, on June 4. There will be one session for the presentation of scientific papers and another for the transaction of business.

The annual meetings of the American Society of Zoologists will be held at Atlantic City on December 28, 29 and 30, inclusive, 1932, instead of on December 27 and 29 as previously announced in Science. This will mean the opening of the meetings on the second day of the American Association for the Advancement of Science program as usual. Hotel headquarters for the Zoologists will be "The Ambassador," where all the sessions will be held. Special features will be two or three round-table conferences on topics selected from the following list: endocrinology, radiation, chemistry of the cell, morphogenesis, general physiology of the cell.

The tenth Colloid Symposium sponsored by the committee on the chemistry of colloids of the National Research Council and the colloid division of the American Chemical Society will be held at Ottawa, Ontario, June 16–18, 1932. Dr. Emil Hatschek, of London, England, will be the guest of honor. A program numbering twenty-seven papers has been arranged by the research council committee of which Harry B. Weiser, Rice Institute, Houston, Texas, is chairman.

THE department of zoology at the University of Minnesota sponsored the following symposium of lectures on glands of internal secretion during the week beginning on May 3: "Physiology of the Ovarian Hormones"; "Hormones Influencing the Primate Endometrium," Frederick L. Hisaw, professor of zoology, University of Wisconsin; "The Reactions of the Testis to Experimental Treatment"; "The Internal Secretions of the Testis," Carl R. Moore, professor of zoology, University of Chicago; "The Hormone of the Adrenal Cortex"; "Physiological Studies on the Adrenal Cortical Hormone," W. W. Swingle, professor of biology, Princeton University.

THE council of the International Association of Wood Anatomists has announced the election of Dr. Samuel J. Record, professor of forest products at Yale University, as secretary-treasurer of the association. The association was constituted at a meeting in Paris last July in conformity with resolutions adopted the year before by wood anatomists attending the fifth International Botanical Congress at Cambridge, England. The purpose of the association is to cooperate in a systematic investigation of the woods of the entire world through the pooling of materials, standardization of terminology and descriptions, and the exploration of little known forest regions. The association has a present membership of fifty investigators in eighteen different countries. The executive council consists of eleven members of eight nationalities, and includes two Americans, namely, Professor Record, of Yale University, and Professor Irving W. Bailey, of Harvard University.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y., ultimately will receive the major portion of the estate of James C. McGuire, engineer, who died December 7, 1930, leaving an estate valued at $1,352,072 net. The residue of the estate will go to the institute after the death of a sister, Miss Mary M. McGuire.

ACCORDING to the London *Times* a new empire center for the scientific study of internal parasites has been established in Canada, with the assistance of a grant from the Empire Marketing Board. New buildings, which will house the Institute of Parasitology, are now being erected by the Quebec Government at Macdonald College, the agricultural college attached to McGill University. The work is to be undertaken at the Macdonald College, and the scheme is being financed for three years jointly by the Empire Marketing Board and the National Research Council of Canada. It marks the first occasion on which the Canadian Government and the Empire Marketing Board have combined to support a joint scheme of research. The *Times* points out that internal parasites are the stock farmers' biggest problems all over the Empire; in Canada alone the annual loss through parasitic infestation is estimated at £4,000,000. It is hoped that the new institute may eventually become an Empire headquarters for the study of internal parasites, somewhat as Onderstepoort, in South Africa, has become recognized as an Empire center for animal diseases research.

FACILITIES for chemical instruction and research at the Michigan College of Mining and Technology, Houghton, were considerably enlarged this spring with the completion of a three-story addition to Koenig Hall, chemistry building. The annex, which with its equipment cost $90,000, adds 13,500 square feet of floor space. Approximately half of this is devoted to five laboratories—chemical engineering, gas and fuel analysis, physical chemistry, qualitative analysis and organic chemistry. The rest of the new structure is used for five instructor's offices, several preparation rooms, sections for photographic and spectroscopic work and three research rooms. Among the apparatus installed in the annex is a horizontal double-effect Swenson evaporator given by the Massachusetts Institute of Technology.

THE New York State Conservation Department has announced the purchase of 24,000 acres of land to be added to the forest preserve. One tract of 21,000 acres in northern Herkimer County, near the Beaver River, is the largest block added to the preserve in recent years. It is extensively wooded with virgin forests. "These purchases," said Henry Morgenthau, conservation commissioner, "show that although the state is obtaining large tracts of land outside of the forest preserve for reforestation purposes, it is not neglecting to preserve itself but is constantly increasing its extent." The other tract of land, just taken over by the commission, consists of 3,000 acres comprising Howland's Island, lying in the Seneca River east of Seneca Falls in Cayuga County. It will be developed into a game refuge or public hunting ground. It consists of meadow land in the Montezuma marshes. It is partly wooded, but most of it is abandoned farm land. The locality is especially suited for pheasants and cottontail rabbits. In addition to Howland's Island proper the purchase includes Campbell or Busk Island and a portion of mainland known as Bluff and Hard Points. It will be developed by the division of Fish and Game of the Conservation Department.

DISCUSSION

RELATIONS OF BIOCLIMATICS TO THE OTHER SCIENCES

As the result of long-continued studies of natural phenomena with special reference to life, climate, seasons and geographical distribution, manuscripts have been prepared for two volumes on a new science of bioclimatics.

This science is new, or at least different from any other branch of the natural sciences, in that it is based on the bioclimatic law and related laws and principles, and that it deals with fundamental principles, systems and methods of applying knowledge of facts and evidence on any subject of life, climate, weather, seasons, geographical distribution and related subjects as recorded in the literature of any branch of science or economic practice related to human interest in general and to local, regional, continental or world agriculture in particular.

Bioclimatics does not, therefore, occupy the field of any branch of the sciences, or duplicate any line of teaching or economic research, but is intended simply to give the results of research on, and the interpretation of, fundamentals which apply alike to all, and to present by means of examples, tables, maps, charts, systems of classification and methods of procedure, by which they may be applied by any research specialist to help solve his specific problems, and especially to serve as a guide to the coordination of certain features of his results, in such a way as to make them available for direct comparison, not only with results attained by other specialists in the same branch of science but with those related to the same general subject in any other branch, and thus contribute to the development of a coordinate system of comparable results for general study and interpretation.

As is well known, the present complexity of major and minor branches, divisions and sections of the natural sciences, with innumerable lines of general and intensive specialization and each developing a more or less different technical language, the old-time naturalist and philosopher has been crowded out of the field and picture. There is no longer any possibility for the naturalist or philosopher, or for any one in a given science, to keep up with or even comprehend the advancements that have been made within recent years in all the sciences.

With the present lack of coordination of methods, or results, with any comprehensive system of laws and principles it is utterly impossible for any one to make a broad comprehensive study and correct interpretation of even the most outstanding results in the major sciences.

It must be generally recognized, therefore, that there is urgent need of some fundamental plan by which the results of various lines of research, relative to a broad subject like agriculture, can be coordinated with some system of basic principles and methods by which comparative study and interpretation can be made towards solving some of the really big problems in agricultural research and economic practice.

The principal object in the development of the science of bioclimatics has been to contribute to this need, and it is believed that it has been attained, at least to the extent of serving as a basis for further development towards an ideal system.

The system as developed is based on certain fundamental laws and principles which apply alike, or in a similar way, to any line of research in any science requiring a general or specific consideration of the basic elements of time, temperature and distance in the relations between life, climate, seasons and geographical distribution.

Thus taking any minor or special subject, as for example a given species of injurious beetle as representing the major science of biology, the major branch zoology and its division entomology, order Coleoptera, the family Scolytidae as a special field of research, forest entomology as the special section of economic entomology, and the southern pine beetle as the insect; every detail in the study of its seasonal activities or seasonal history involves elements of the fundamental laws of cause as manifested in the motions of the earth and the energy of the sun, and of effects in time and the seasons, climate and weather, distribution by distance in degrees of latitude, longitude, and feet of altitude, events in the seasonal development of the insect and its host plant, are all coordinate elements of the causes and effects of a bioclimatic complex. The normal temperature of the year and of the warmest and coldest months of the nearest meteorological station indicate the local type of climate and type of bioclimatic zone, the dates and periods of the seasonal events of the insect and its host plant indicate the type of season, the geographic position of the local area in which the insect occurs will indicate its latitude and altitude distribution, while its control depends on the selection of the proper time in the season for the application of control measures, which will differ with distance north, south, east or west of a given local area, as it will with higher and lower altitudes in the same general area.

Thus, this or any other form of life represents the ultimate effects of all of the major and minor laws and factors of cause, or of the causation complex, from the motions of the earth and the energy of the sun down to the local climate, weather, seasons and zonal type, and the ecological type of its immediate environment. So that, in order to know about a single form of life, it is necessary to know about the laws and principles which have governed its origin, evolution, survival and dispersal within its present geographical limits, and its present relations to all other forms of life coming within the same zone of climatic influence. In fact, "to know all about any one thing in nature it is necessary to know all about everything," which, of course is far beyond the capacity of the human mind individually or collectively. When, however, it is known from the accumulation of knowledge and special original research that there are certain fundamental major and minor laws and factors of nature, the effects of which are represented on the surface of the earth by the phenomena of life, seasons, weather and their variation in character or type with geographic distance, and that with the development of a comprehensive system of coordinate bioclimatic elements and of principles and methods of application the records of the bioclimatic elements of any geographic position can be analyzed, the major and minor bioclimatic zones and the zonal, climatic, seasons and weather types it represents can be interpreted. So that a large part of the essential knowledge on which to base specific scientific research on any form of life or any related subject can be made available to the research specialist. In other words, the specalist can take the preliminary interpretations of the fundamental laws and principles, which are represented alike by all of the elements of the local phenomena, and begin his work where his immediate problems of supplying additional information begins.

ANDREW D. HOPKINS

PARKERSBURG, WEST VIRGINIA

PERIGLACIAL PHENOMENA IN THE PUGET SOUND REGION

IN the Arctic and sub-Arctic lands and also in the high mountains intensive frost action produces distinctive structures in the surface soil. These "reticulated" or "cellular" soils have been described from many localities by me and by many other observers.[1] The published discussion of this subject by Bryan[2] and a recent conversation with him have recalled to my attention observations made some years ago in the Puget Sound region. Here on the prairies in the vicinity of American Lake, southwest of Olympia, Washington, are gravel outwash plains of the earlier ice advance. These localities were outside the border of the last (Wisconsin) ice and, therefore, must have endured a periglacial climate. The most significant features are segregations of gravel and soil that have a reticulated pattern. Over large areas the surface is divided into approximately equidimensional patches of soil nearly clear of stones that are separated from each other by narrow strips of gravel and boulders having an open texture and little or no interstitial soil. As a general rule the soil patches stand higher than the boulder septae. In many places the margins of the boulder septae are higher than their centers. Major lines of boulder concentrations persist for long distances and branch up slope in characteristic drainage arrangement. In other words, one accustomed to the Far North finds here, under a present genial climate, a thoroughly familiar set of features, identical in every respect with the products of sub-Arctic frost rearrangement of mixed alluvial materials.

There are also areas in which the gravels are hidden by broad parallel ridges of black soil. These were developed at the time of glacial recession but are not indicative of any peculiarities of the climate of the time. Such ridges are normal forms of deposition from broad sheet-flow of silty or turbid water and are developed as readily in warm climates as in cold. Flood deposits in the alluvial valley of the Mississippi of both modern and fairly ancient origin show these same forms. The unusual dark color of the ridge soils of the Puget Sound region is the result of the growth and decay of the common brake.

The existence near Olympia of reticulated soils that testify to the existence of a Wisconsin periglacial climate should lead to search for other similar phenomena within the area and to further use of such criteria in the interpretation of the earlier glacial deposits along lines of attack similar to that already initiated in the Central States.[3]

HENRY M. EAKIN,
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METER IN COMPOSITION

IN the issue of SCIENCE for October 30 is an interesting note by G. S. Fraps on "Hybrid Words." In closing, he says: "The English language would be in better shape if some people knew less Greek and Latin." Perhaps it would be better to say that the English language would be in better shape, if everyone, especially scientists, knew more of these languages and would be more careful and less pedantic in using the very little they usually know. Hybrids of all kinds offend good taste. Even the lovable mongrel dog can not be admitted into good canine society. A silk hat must not be worn with any kind of a coat. Every one of refinement is careful to have each article of dress conform to a certain scheme. In the army and navy an officer may on certain occasions wear either all citizen's clothes, or all uniform. He must not wear his uniform cap with a gray sack suit.

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[1] "The Yukon-Koyukuk Region, Alaska," U. S. Geol. Survey Bull., 631, pp. 75–82. 1916; B. Hogbom, "Uber die geologische Bedeutung des Frostes," Geol. Inst. Uppsala, Bull., vol. 12, pp. 258–390, 1913; W. Salomon, "Arctische Bodenformen in dem Alpen," Heidelbergen Akad. Wiss. Naturw. Kl. Sitz-Ber., Pt. 5, pp. 1–30, 3 pls., 1929.

[2] Kirk Bryan, "Glacial Climate in Non-glaciated Regions," etc., *Amer. Jour. Sci.*, 5th ser., vol. 16, pp. 162–164, 1928. Also "New Criteria Applied to the Glacial Geology of Southeastern Massachusetts," *abst.:* Geol. Soc. Amer. Bull., 1932.

[3] G. F. Kay, "Origin of the Pebble Band on Iowan Till," *Jour. Geol.*, vol. 39, pp. 381–385, 1931.

The same principle holds true with regard to cultivated taste in the formation of words. Just as one does not generally approve of racial mixtures, so good taste is offended by mongrel words which are the misbegotten offspring of linguistic miscegenation. Doctors seem to be the worst offenders in this matter. They know little or no Greek, but they miss no opportunity to work in what little they think they know in order to mystify or impress. They are devoted, for instance, to hyper and hypo in place of super and sub in composition with Latin stems. All doctors, I am told, say "hypersensitive" and "hypertension." This sounds more learned and is less likely to be understood than supersensitive and supertension. In fact, doctors seem to be quite "hyperstitious" about Greek and somewhat "hypercilious" in the use of it.

But some mixtures are admissible. Greek words have been thoroughly naturalized as Latin, and both Greek and Latin words have been admitted into good English society. The ending "ology" is an example. We even have roentgenology. Many are violently opposed to the anti-prohibitionists, but no one objects to the word. The advocates of "Shapometer" may find some comfort in the fact that meter seems to have been adopted as a legitimate English word. Originally Greek, it was first adopted into Latin and we have many Latin stems combined with it. In the metric system we have millimeters as well as kilometers. Then, as signifying an instrument of measurement, we have it in all sorts of combinations. In voltameter and voltmeter the first element is an Italian proper name. We already have speedometer, why not shapometer? People might well be pardoned for using this last combination, provided they will refrain from accenting kilometer on the second syllable.

Many thousands of our boys went to France who had never used the metric system. There they encountered kilometer and naturally made it rhyme with the familiar speedometer. The sad thing is that many scientists have now fallen into this error. Soon we shall have centimeters and millimeters accented in the same way. But one is not easily surprised at any departure from linguistic orthodoxy when a learned scientist in your columns not long ago aired his learning by saying grandly "cacodorous" and "polyvalent" for the perfectly nice words "malodorous" and "multivalent."

GEORGE W. LAY

CHAPEL HILL, N. C.

ACADEMIC FREEDOM IN SPAIN

DR. NONIDEZ' reply to my letter of April 15 is a typical example of "it depends on whose ox is gored." The case of nine Italian professors out of over twelve hundred who are forbidden to teach in state universities because they refuse to take an oath of allegiance to the state is an attack on academic freedom; the case of perhaps twelve hundred Spanish professors who are forbidden to teach in private schools because of a fictitious vow is not an attack on academic freedom.

I too received part of my education in Spain and know conditions there, but I had the good fortune to have been born and reared in the United States which is a republic in fact and not merely in name. I agree with Dr. Nonidez that "the suppression of the Jesuits with the advent of the new order was a foregone conclusion," but not for the reason he assigns. The Jesuit fourth vow has nothing to do with allegiance to a foreign power. It has a very specific object, and one only, and that is to go on the missions when commanded by the Pope as head of the Church. That this vow was a pretext to cover a gross injustice is shown by the fact that, unlike the communists of whom the writer speaks, the Jesuits were not deported as they should have been had they vowed allegiance to a foreign power, but only deprived of their right to teach and hold property.

The fact that the Jesuits were formerly exiled, even by "His Most Catholic Majesty, Charles III," is no excuse for "less severe" treatment by a so-called republican government.

P. H. YANCEY, S.J.

DURABLE FILMS

THE Aristogenic Association is engaged in making records of the characteristics of men thought to be of great service to humanity. An endeavor is being made to make the records as objective as possible, *i.e.*, to present their own evidence. Therefore the motion picture, photograph and x-ray are extensively employed. Since it is desired to preserve a copy of these records intact for release at the end of a century, they must be durable. There is, however, some doubt as to the best methods of preserving them for so long a time. The usual sources of information are indecisive.

We should appreciate any useful data or suggestions.

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SPECIAL ARTICLES

THE DEFLECTION OF LIGHT IN THE SUN'S GRAVITATIONAL FIELD

AMONG the various expeditions sent out to observe the total solar eclipse of May 9, 1929, that of the Potsdam Observatory (Einstein Stiftung) seems to be the only one which obtained photographs suitable for determining the light deflection in the sun's gravitational field. Two instruments were used, but so far only the results of the larger one, a 28-foot horizontal camera combined with a coelostat, have been published. The three observers, Freundlich, von Klüber, von Brunn,[1] claim that these observations (4 plates containing from 17 to 18 star images each) lead to a value of 2″.24 for the deflection of a light ray grazing the sun's edge; a figure that deviates considerably from the results of the 1922 eclipse, and which is in contradiction to Einstein's generalized theory of relativity. In view of the importance and general interest attached to this problem, a few critical remarks on the Potsdam observations and their reduction should not be out of place here[2]:

(1) The accuracy claimed for the Potsdam result is somewhat illusory. A more liberal discussion of the residuals would lead to a probable error of at least ± 0″.10 (mean error ± 0″.15), 50 per cent. larger than that given by the observers; but even this does not fully take into account the uncertainty in the adopted scale difference of the plates.

(2) The star field of the 1929 eclipse was unfavorable, for of the 18 stars bright enough to be photographed on the Potsdam plates, 17 were located on one side of the sun and only one star on the other side. That is, we may draw a straight line through the center of the sun such that a single star is on one side of the line and the other 17 stars are on the other side. This extremely unsymmetrical star distribution has the consequence that the light deflections to be determined depend to a high degree on the plate constants used in the reduction; and five such constants for each plate had to be derived from the star measures.

(3) The Potsdam reduction is based on the assumption (in accord with the Einstein theory) that the light deflection is inversely proportional to the star's angular distance from the sun's center. However, the deflections determined by the Potsdam observers are not in accord with this Einsteinian requirement. When the stars are arranged according to their angular distances from the sun's center, a systematic run in the radial components of the residuals is apparent. Among the 6 stars nearest to the sun, 5 have negative residuals, while of the 6 most distant ones 5 have positive residuals. This leads to the conclusion, either that the Potsdam observations are affected by a systematic error, or that the assumption on which the reduction is based is incorrect. Ludendorff[3] has investigated the question of a systematic measuring error; the evidence presented in the following indicates that the fault lies in the scale determination.

(4) In our problem the most important correction to be applied to the differential measures of an eclipse photograph and a photograph of the same (eclipse) group of stars obtained at night for comparison purposes several months before or after the eclipse date is the scale difference between the two plates. The Potsdam observers tried to determine this scale difference independently of the star observations. By means of a collimating telescope, a reseau of fine lines was copied on each of the eclipse plates as well as on the comparison plates, and the observers assumed that the angle corresponding to a reseau interval remained unchanged during the period of from 5 to 7 months which elapsed between the eclipse and the comparison observations. This assumption, however, has no sound foundation. The temperature at the time of the comparison observations (secured at night) was on the average 5° C. lower than during the eclipse, and the tube of the collimating telescope, and in consequence the intervals between the reseau lines recorded on the eclipse and comparison photographs, must have suffered changes due to temperature changes. In fact, the probable temperature effect neglected by the Potsdam observers would be of the right sign and order of magnitude to account for the excess of the observed light deflection over the requirements of the Einstein theory.

(5) Originally the Potsdam expedition in its plans had foreseen the possibility of a change in the collimator-reseau combination. A duplicate horizontal camera was utilized to photograph, at the time of the eclipse, another star field far to one side of the eclipsed sun, and therefore not subject to appreciable Einsteinian deflections; the photographs thus secured, when compared with photographs of this star field obtained at night, to be used in checking or measuring the effects of such a change. Unfortunately the optical qualities of this second telescope were somewhat defective (perhaps because of strains in the objective at the time of the comparison observations), so that photographs of the reseau's straight lines show optical distortion. The observations of the second tele-

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[1] Abhandl. d. Preuss. Akad. d. Wissensch., 1931, Math. Phys. Kl. No. 1; *Zeitschr. f. Astrophysik*, 3, 171, 1931.

[2] A fuller account is being published in the *Zeitschrift für Astrophysik.*

[3] *Astron. Nachr.*, 244, 321 and 415, 1932.

scope can therefore not serve their purpose, and without this check the Potsdam scale determination deserves no confidence and should be rejected.

(6) The Potsdam measures can nevertheless be utilized for the study of light deflections, if the scale correction is determined with the other plate corrections from the star observations themselves, a procedure similar to that employed at the 1919 and 1922 eclipses. On account of the unsymmetrical distribution of the stars it is in this case important that all plate constants should be redetermined when the scale value is added as another unknown.[4] A new reduction of the Potsdam measures made by me on this basis leads to a value of:

$$E = 1''.75 \pm 0''.13 \text{ (p.e.)}$$

for the light deflection at the sun's limb, which is in precise agreement with the Einstein theory, as well as in good accord with the earlier observations. The small probable error proves the excellent accuracy of the Potsdam *measures* and entitles this result to carry some weight among the former determinations of light deflection (see Table I).

(7) The residuals from the new solution are much more satisfactory than those of the original reduction. The law of inverse proportionality of the light deflections and the angular distances from the sun's center is now quite well fulfilled; the radial components of the residuals no longer show the systematic run mentioned under (3); and the sum of their squares is reduced to less than half its former amount.

(8) In the Potsdam publication objections are raised against the reduction of the 1922 observations made by the Lick Observatory expedition, and a new reduction of the Lick observations undertaken at Potsdam is mentioned as giving much larger values for E (around 2″.2). Closely examined, the Potsdam formula proposed for the solution of the 1922 observations, *though differing in form,* is equivalent to the one used by the Lick observers. The difference in method lies merely in the fact that the Potsdam observers arbitrarily divided the stars into two groups according to their distances from the sun's center, using the outer stars only for the scale determination, and the inner ones only for the light deflection; whereas the Lick observers, by the method of least squares, derived both unknowns simultaneously from all stars. Check calculations showed in fact that the two methods give practically identical results.

(9) The larger result which the Potsdam observers obtain from the Lick observations is thus not due to any difference in the method, but to an unsuitable choice of weights and the arbitrary exclusion of certain stars. Instead of using the weights established by the observers, the Potsdam authors simplified their calculations by rejecting stars having smaller weights than one eighth of the maximum weight, and giving all other stars equal weights, regardless of the number of plates on which they were measured. But even if this remarkable weighting practice is adhered to, it does not lead to the large value of the light deflection quoted in the Potsdam publication. The latter could only follow (provided there are no mistakes in the

TABLE I

DETERMINATIONS OF LIGHT DEFLECTION IN THE SUN'S GRAVITATIONAL FIELD

Eclipse	Observing station	Telescope Aper.	Telescope Foc. l.	No. of plates	No. of stars	Light deflection sun's limb	Prob. error	Remarks	Observers
1919 May 29	Sobral	4-in.	19-ft.	7	7	1″.98	±″.12		Dyson Davidson Eddington
	Sobral	8	11	16	6–12	(0.86)	± .1	(1)	
	Principe	8	11	2	5	1.61	± .3		
1922 Sept. 21	Wallal	6	10	2	18	1.74	± .3		Chant Young
	Wallal	5	15	4	62–85	1.72	± .11	(2)	Campbell Trumpler
		4	5	6	134–143	1.82	± .15	(3)	
	Cordillo-Downs	3	5	2	14	1.77	± .3		Dodwell Davidson
1929 May 9	Takengon	8	28	4	17–18	1.75	± .13	(4)	Freundlich v. Klüber v. Brunn
	Weighted mean					1″.79	±″.06	(5)	

Remarks: (1) Poor focus, rejected by observers; not used for the mean.
(2) If "corrected" for check-field residuals: 2″.05.
(3) If "corrected" for check-field residuals: 1″.71.
(4) New reduction by Trumpler; original reduction by observers: 2″.24.
(5) Weights according to p.e. of individual results; p.e. of mean from sum of weights.

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[4] A solution of the Potsdam residuals for Einstein term and scale correction alone was made by Jackson (The Observatory 54, 292, 1931), which led to a value of 1″.98. The considerably smaller result of our complete solution is mainly due to the change in the zero point, which must accompany any alteration in the scale value and the Einstein term.

Potsdam numerical calculations) if additional stars, mostly those *giving negative residuals*, were rejected. Such an arbitary exclusion of observations, however, is against the rules of the theory of errors, and it deprives the result of any value.

(10) In the publication of the 15-foot camera observations, secured by the Lick expedition of 1922, attention was drawn[5] to a run in the residuals of the check star field (photographed on the nights before and after the eclipse). Since the origin and reality of these small residuals are quite doubtful, the observers based their final result (1.″72) on the observed (uncorrected) star displacements D_1. Freundlich, von Klüber, and von Brunn, on the other hand, give preference to the figure 2.″05 obtained from the star displacements D_2 which are "corrected" for these uncertain residuals of the check field. It is true that this choice is a matter of personal judgment, but whatever the choice, the same procedure should be employed for both pairs of instruments used by the Lick expedition. The adoption of the Potsdam view-point would require that the observations secured with the Lick pair of 5-foot cameras[6] be similarly "corrected" for the check-field residuals, and this would lead to a slightly smaller value (1.″71). The mean of the results given by the two pairs of instruments would then be 1.″9, which still agrees with Einstein's prediction within the limits of permissible observational error.

Summary

The scale determination for the 28-foot camera, on which the published result of the Potsdam expedition is based, is unsatisfactory and should be rejected. A new reduction of the Potsdam measures, in which the scale correction is determined from the star observations, yields a result of $E = 1.''75 \pm 0.''13$ for the light deflection at the sun's limb, and considerably reduces the residuals of the observations. The objections of the Potsdam observers against the reduction of the 1922 observations are not valid, and there is no reason to change the results published by the Lick observers. The various measures of light deflection at the sun's edge thus far available are listed in the following table; their weighted mean is 1.″79 ± .″06.

Robert J. Trumpler

Zurich (Switzerland), March 29, 1932

NORMAL TISSUES AS A POSSIBLE SOURCE OF INHIBITOR FOR TUMORS[1]

The presence of an inhibitor associated with the causative agent of a chicken tumor has been reported in recent communications. While the tumor agent is more or less species specific the inhibitor from the sarcoma has been found to affect definitely a transplanted sarcoma of mice. The results of these observations and others on the properties of the causative agent led to the suggestion that the mechanism involved in the induction and growth of the chicken tumor may be an unbalanced but similar mechanism to that which controls growth and differentiation of normal tissues. This conception led to attempts to separate the hypothetical stimulating and retarding factors from active normal tissues. We have discussed elsewhere the limited evidence indicating the possibility of inducing malignant transformation by means of the growth-augmenting factor. The present paper is a report of experiments which suggest that an inhibiting factor may be extracted from certain normal tissues.

The inhibitor or balancing factor might be expected to occur where there is a greater concentration of the stimulator. Therefore we have used active tissues as the source of our test materials. Preliminary experiments with extracts of whole fresh embryos and placenta of the mouse, treated in the same way as the chicken tumor extract, *i.e.*, heated to 55° C. for 30 minutes, had little influence on either transplantable carcinoma or sarcoma of the mouse. Profiting by the experiments with chickens, where the tumor desiccate yielded more definite amounts of the inhibitor, we changed the method to the following:

Method: The test tissues consisted principally of placenta, whole embryo, embryo skin and skinless embryo of the mouse. The tissues were macerated, spread in thin layers in a sterile dish, frozen and dried *in vacuo*. These desiccates were ground to a fine powder, extracted with a small amount of water, centrifuged and the supernatant fluid tested on tumors. The carcinoma used for inoculation was cut up into the usual size grafts and part of these immersed in the suspension made from the dried tissues and part in normal salt solution for controls. Usually two or three nicks were made in the grafts to give a greater area of exposure to the fluids. The time of contact allowed was only that required to load the grafts into trocars for inoculation. With the Crocker sarcoma 180 a suspension of the cells was made by forcing the tumor through a fine grill and 1 cc of the cells suspended in 3 cc of salt solution. This suspension was added to an equal amount of the tissue extract and 0.05 cc injected immediately into mice. For the controls the suspensions were diluted in the same proportion with Ringer's solution. The treated tumor was inoculated into one groin and the control into the other. Additional mice were inoculated with the control material alone. In some experiments the suspensions prepared from dry tissues were heated at 52° for 30 minutes, but as this treatment had little effect on the results they will not be presented separately. The outcome of eight experiments in which desiccated skin from mouse embryos was the test material are given in Table I.

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[5] *L. O. Bull.*, 11, 54, 1923.

[6] *L. O. Bull.*, 13, 130, 1928.

[1] From the Laboratories of the Rockefeller Institute for Medical Research.

TABLE I

Material inoculated	Number inoculated	Number negative	Per cent. negative
Carcinoma No. 63 plus extract embryo skin	128	74	57.8
Carcinoma No. 63 plus Ringer's solution	164	29	17.7
Sarcoma No. 180 plus extract embryo skin	40	1	2.5
Sarcoma No. 180 plus Ringer's solution	59	0	0

The second material tested for possible inhibiting action was desiccated mouse placenta. The results with the two tumors are shown in Table II.

TABLE II

Material inoculated	Number inoculated	Number negative	Per cent. negative
Carcinoma No. 63 plus extract of placenta	158	98	62
Carcinoma No. 63 plus Ringer's solution	234	49	20.9
Sarcoma No. 180 plus extract of placenta	86	0	0
Sarcoma No. 180 plus Ringer's solution	129	1	0.7

The inhibiting action of the extracts was shown not only by the low percentage of takes resulting from inoculation of the carcinoma grafts treated with the extracts, but also by the fact that the tumors that did arise from these inoculations were on the average much smaller than the controls. It is evident that neither of these extracts tested had any retarding action on Mouse Sarcoma 180. Extracts of fresh tissues tested included whole embryo, embryo skin, skinless embryo and placenta; those of desiccated tissues, whole embryo and skinless embryo. None of these extracts, heated or unheated, had any significant effect on either of the tumors tested, nor on another sarcoma of the mouse (S/37). A few preliminary experiments on the local injection of these extracts about an established tumor have shown no evidence of retarding growth.

The principal value of the general observation is the possible light thrown on the nature of the mechanism involved in malignancy. The relation of this factor from normal tissues to the inhibitor from the chicken sarcoma will be discussed in a subsequent paper when more definite information is available.

James B. Murphy
Ernest Sturm

META-AMINO PARA-HYDROXY PHENYL ARSINE OXIDE AS AN ANTI-SYPHILITIC AGENT

This trivalent arsenical preparation, meta-amino para-hydroxy phenyl arsine oxide, studied by Ehrlich and Bertheim, later by Voegtlin and others, has generally been thought to be the most important effective breakdown product of the arsphenamines. It is relatively toxic and on this account its use has been heretofore limited to purely experimental fields. Our own theoretical interests led us to study this substance first as a trypanocide, then later in experimental syphilis. We soon found that in experimental trypanosomiasis, the therapeutic index was relatively very high compared to most other effective agents. In rabbit syphilis, we found the therapeutic index to be higher than for any other single antisyphilitic agent known to us. So far as we are aware, it had never received a trial in the treatment of human syphilis.

We have felt for some time that absolute toxicity alone is without special significance, but that the ratio of curative dose to the toxic dose furnishes real evidence of promise. On the basis of abundant data obtained in our laboratories, we readily enlisted the interest of Drs. W. F. Lorenz and W. J. Bleckwenn, of our Department of Neuropsychiatry, and Drs. O. H. and H. R. Foerster, R. L. McIntosh, and L. R. Wieder, of our Department of Dermatology. Complete reports of clinical investigations in the use of this drug will be made in due time by our clinical colleagues. Suffice it to say at this time that sixty patients have received, collectively, a total of seven hundred intravenous injections of this drug in quantities varying from 5 up to 130 milligrams per dose. The usual dosage ranges from 30 to 60 milligrams for the single dose.

Clinically, the results have been exceedingly promising, both in therapeutic effects and freedom from toxic manifestations. We fully realize the necessity, however, of a very careful and prolonged study before a full report can be made on questions of thoroughness of disinfection, optimal dosage, freedom from possible serious toxic manifestations, and practical utility in the treatment of syphilis in its several stages, when used alone and in conjunction with mercury or bismuth.

We have been designating this drug as "158," or more or less tentatively by the name *Mapharsen* from (m)*eta*-(a)*mino*-(p)*ara*-(h)*ydroxy* (ars)*ine* oxide. This drug was first prepared for us by Professor C. S. Hamilton, of the University of Nebraska, and later by the Research Department of Parke, Davis & Company, which has been kindly supplying the larger quantities necessitated by more extensive and intensive studies.

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AIRPLANE OILING TO CONTROL MOSQUITOES[1]

THE airplane has already shown its usefulness in dusting large swamp areas with Paris green[2, 3] in control of *Anopheles* mosquito larvae. In New Jersey swamps and marshes, where the larvae of the prevailing species of mosquitoes are primarily bottom feeders, Paris green or any other arsenical dust does not produce efficient control, except when applied in such large quantities as to become an actual menace of poisoning animals and men. This danger is especially feared on mosquito breeding areas, located in close proximity to congested cities and towns. Experiments with other dust larvicides, such as various toxic oils and tar hydrocarbons incorporated in inert carriers such as kaolin, peat moss, sawdust, etc., have thus far not proven successful.

While these experiments are in progress, the mosquito control workers in New Jersey and in other states are still confronted with many large areas of swamps and marshes which can not be successfully drained and which are inaccessible from land for mosquito eradication.

In view of the fact that these mosquito breeding areas can not be efficiently oiled from land, the possibility of applying oil or liquid larvicide by the aid of an airplane has presented itself. Accordingly, experiments were carried out during the summer of 1931, the results of which are here presented.

EXPERIMENTAL

For this purpose an airplane was procured from the Unger Aircraft Corporation, located at Hadley Flying Field, New Jersey, and was equipped with the necessary apparatus for the experiment. Two tanks, of about 50 gallons capacity each, were installed in the forward cockpit of the plane and were connected to a steel pipe 3 inches in diameter. This pipe extends along the bottom of the fuselage throughout the length of the plane, terminating just below the rudder in a cross pipe, 7 feet long and 1½ inches in diameter. This horizontal pipe is perforated with holes ranging from ⅛ to ¼ of an inch in diameter and serves the purpose of a nozzle from which the liquid flows out.

A valve, placed at the rear end of the longitudinal pipe, and operated by the pilot from his cockpit, controls the flow of the oil. This entire equipment is removable and the plane can be used for other flying purposes. The actual application of the larvicide is carried out in the following manner. As soon as the loaded plane reaches the area to be treated the pilot is warned by flags or signals, previously agreed upon, where the larvicide should be sprayed. The pilot then swoops down as low as possible within safety limits and releases the valve. The liquid flows out by the force of gravity as a fine spray, depositing a thin film on the breeding areas.

By this method both pyrethrum larvicide[4, 5] and oil were tested in Morris and Middlesex Counties. The results thus far obtained have shown that on a still day when there is no appreciable wind to blow away the larvicide from its course, a killing film of oil or larvicide is deposited on the surface of the breeding area.

The last two experiments carried out on the Cheesequake salt marsh meadow and on the Florham upland meadow, have produced very encouraging results. Practically complete kill of larvae and pupae in each case was obtained. About 8 acres of the Florham meadow were covered with a killing film of oil in about 40 minutes. The amount of oil required for this purpose was about 140 gallons. The cost of the application, as estimated by several field men experienced in mosquito control work, was found to be cheaper than hand oiling.

While this problem is still under investigation, the preliminary results thus far obtained indicate that on certain large breeding places where the entire area has to be oiled, successful control may be obtained by applying oil or other liquid larvicides from a properly equipped airplane. This method, however, may prove uneconomical on such marshes or swamps where the breeding is scattered and where coverage of the entire area is not necessary.

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NEW BRUNSWICK, N. J.

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[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

[2] W. V. King and G. H. Bradley, "Airplane Dusting in the Control of Malaria Mosquitoes," U. S. D. A. Department Circular No. 367, 1926.

[3] L. L. Williams and S. S. Cook, "Paris Green Applied by Airplane in the Control of *Anopheles* Production," Public Health Report, p. 459, Reprint No. 1140, 1927.

[4] J. M. Ginsburg, "Studies of Pyrethrum as a Mosquito Larvicide," Proceedings of the 17th Annual Meeting of the New Jersey Mosquito Extermination Association, p. 57, 1930.

[5] R. L. Vannote and J. M. Ginsburg, "Practical Application of Pyrethrum Mosquito Larvicide," Proceedings of the 18th Annual Meeting of the New Jersey Mosquito Extermination Association, p. 111, 1931.

THE NATIONAL ACADEMY OF SCIENCES

PAPERS PRESENTED AT THE WASHINGTON MEETING

AT the annual meeting of the National Academy of Sciences, held in Washington on April 25, 26 and 27, the following papers were presented:

The cure of drug addicts: WILDER D. BANCROFT, R. S. GUTSELL and J. E. RUTZLER, JR. Morphine coagulates albumin, and sodium rhodanate should therefore counteract the effects of morphine. We have shown that it does for rabbits, dogs and men. Since sodium rhodanate is said to increase the activity of the tuberculosis bacillus, sodium rhodanate should not be given to a tuberculosis patient. If a patient has taken morphine to minimize the pain from some such disease as cancer, there is nothing permanent to be gained by curing the drug habit unless one can alleviate the pain. From experiments on six patients we believe that it is possible to cure any drug addict who is not tuberculous, who does not have a weak heart, who does not suffer from a pain-producing disease and who really wants to be cured. This last is very important. If a man is down and out after the treatment, he will probably relapse. If he is a criminal addict and his friends take drugs, he will probably relapse. He will not relapse because of tremendous depression or an intense craving; and he can pull himself out again without much trouble if he wishes to. One patient did. While we believe that we have proved that it is not necessary for anybody without the special complications to remain a drug addict, we do not feel that the details of treatment are standardized. Our patients all have some delirium, which is probably unnecessary. Since many drug addicts have psychoses, it is also necessary to cure the psychosis, which means that this work is tied up with the treatment of the insane.

A study of van der Waals forces between tetrahalide molecules: J. H. HILDEBRAND and J. M. CARTER. A knowledge of van der Waals forces is essential to an understanding of many problems involving properties of gases, liquids and solids and the transitions between them. The approach of the authors is chiefly through the problem of solubility. In order to avoid dipole forces it was desired to investigate molecules of the highest possible symmetry, and for this the tetrahalides appeared most suitable, owing to the variety offered by their molecular sizes and fields. The authors have worked with the liquid tetrachlorides of carbon, titanium, silicon and tin and the tetrabromides of the last two. The properties thus far measured have been the expansion on mixing and the change in pressure with temperature at constant volume, the latter property for the six pure liquids and for eight of their mixtures. From this can be calculated the coefficient of energy with respect to volume, $(\partial E/\partial v)_T$. This is given with great accuracy for the range studied by the van der Waals function, a/v^2. The values of a are as follows, in atmospheres times liters squared: carbon tetrachloride, 31.21; silicon tetrachloride, 34.00; silicon tetrabromide, 53.36; titanium tetrachloride, 41.90; stannic chloride, 44.84; stannic bromide, 64.79. These values are only approximately simple functions of the molecular dimensions, even for the chlorides. Values for eight mixtures were measured and their relation to the values for the pure liquids discussed. The value of a between different molecules is given by the van der Waals relation $a_{12} = \sqrt{a_1 a_2}$ with a maximum disagreement of 2.2 per cent. However, the agreement between observed and calculated values for the solutions is better if the function $v(\partial E/\partial v)_T$ is regarded as additive. The maximum deviations for both relations as well as the maximum expansion on mixing is shown by the tetrachlorides of carbon and tin, although these do not represent extreme members of the series according to any of the properties considered. This is taken to indicate that the tin-halogen bond is more or less polar. The vapor pressures of these solutions are being measured in order to test theoretical connections between intermolecular forces and deviations from ideal solution laws.

Some new contributions to nucleic acid chemistry: P. A. LEVENE, R. S. TIPSON and S. A. HARRIS. The complex nucleic acids are composed of several nucleotides. Each nucleotide is, in turn, a glycoside of ribosephosphoric acid. A complete knowledge of their structure requires information as to the ring structure of the riboside and the location of the phosphoric acid radicle on the sugar. The first of these two problems has now been solved satisfactorily in the following way: Adenosine was acetylated and the acetyl derivative was methylated. The trimethyl ribose obtained from it differed in optical rotation and in other physical properties from the trimethyl-d-ribose derived from the normal-methyl-d-riboside and hence did not possess the pyranose structure. Furthermore, on rigorous oxidation it yielded (i)-dimethoxy succinic acid, thus establishing the furanose structure of the nucleoside. For the solution of the second problem it was necessary to find a method for partial hydrolysis of the nucleotides in a way which would yield ribosephosphoric acid. After many failures the following method was devised. Guanylic acid was converted by diazotization into xanthylic acid. The latter on standing in aqueous solution at its own pH at 50° yielded the desired substance. In the substance obtained in this manner the location of the phosphoric acid residue is restricted to one of two possible positions, namely, carbon atoms 2 or 3 of the sugar.

The chemical bond: GILBERT N. LEWIS.

Combination of carbon monoxide and oxygen under the influence of radon: S. C. LIND and CHARLES ROSENBLUM. When alpha particles traverse a gas or mixture of gases capable of reacting chemically under this influence, the amount of reaction is proportional to the ionization produced in the gas phase. It has been found that when a foreign gas is also present, its ions contribute to the amount of chemical action in the same degree as if they were ions of the reactant gas. Carbon dioxide, however, appeared to behave *abnormally*. In the oxidation of CO or CH_4 by oxygen, the CO_2 generated did not appear to contribute to, or disturb, the course of the reaction even when the quantity of CO_2 produced exceeded the quantity of the reactants by several fold. This abnormality has been examined by adding an excess of CO_2 to a mixture of $2CO + O_2$ before any reaction had taken place. It has been found that CO_2 ions do have an enhancing effect, but one that is only about 14.5 per cent. efficient. In addition, the effect of recoil atoms has been examined in this reaction. Its magnitude is that predicted from the synthesis of water by radon after taking into account the differences in stopping power, specific ionization and the fact that gaseous CO_2 does not condense like H_2O vapor and, therefore, serves to screen partially the recoil atom effect, thus diminishing its intensity. The influence of the size of the reaction vessels (spheres) has also been investigated with a result which confirms the law of the inverse square of the diameter which results from considering the linear paths of the alpha particles in small spheres and the pressure change produced by the chemical action.

The rediscovery of nitryl chloride: WILLIAM ALBERT NOYES. In 1862 Richard Müller gave an accurate description of the preparation, properties, analysis and determination of the vapor density of nitryl chloride, NO_2Cl. Several other chemists claimed that they had obtained the compound, but in 1905 Gutbier and Lohmann obtained only nitrosyl chloride, NOCl, in their attempts to repeat the work of former observers and came to the conclusion that the compound does not exist. During a study of the reaction between nitrogen tetroxide and nitrogen trichloride evidence was obtained indicating the presence of nitryl chloride among the products of the reaction. A repetition of some of the work of Richard Müller has also given a small amount of the compound.

Resonance of a molecule among several electronic structures: LINUS PAULING (introduced by A. A. Noyes). A study of energy relations and interatomic distances has shown that many molecules in the normal state can not be represented by a single electronic structure of the Lewis type, but instead resonate among several. The recognition of this phenomenon clarifies a number of previously puzzling points relative to the correlation and explanation of physical and chemical properties.

Experiments on the nature of the structural unit of metals: ALFRED STOCK (by invitation). On the electrolysis of solutions of the boron hydrides B_2H_6, B_4H_{10} and $B_{10}H_{14}$ in liquid ammonia. This work is a section of the investigations carried on for a number of decades, in Stock's laboratory, into the chemistry of boron. It was carried out by the high-vacuum method, whereby the substances come in contact with only glass and mercury, under the complete exclusion of air and moisture. The experiments showed definitely that the ammonia compounds of the above hydrides must be regarded as salts of ammonia, and the hydrides themselves as acids.

Biographical memoir of Edward Charles Pickering: HARLOW SHAPLEY. (Read by title.)

Biographical memoir of Solon Irving Bailey: HARLOW SHAPLEY. (Read by title.)

Biographical memoir of Frank Wigglesworth Clarke: L. M. DENNIS. (Read by title.)

Biographical memoir of Arthur Williams Wright: E. S. DANA. (Read by title.)

The racial element in human metabolism: FRANCIS G. BENEDICT. A recent survey of the metabolism measurements of Mayas in Yucatan, the pure-blooded aboriginals of the Kokata Tribe in South Australia, Tamils and Malayalis in Madras, and a group of American-born, pure-blooded Chinese girls in Boston has demonstrated clearly that wide differences in the heat production of these various groups exist. They can not be explained on account of size, and only in part by sex differences, and with due regard to all possible differences in dietetic habits and climatic conditions, the assumption of a definite racial factor is justified.

Experiments on the mode of infection and means of prevention of poliomyelitis: SIMON FLEXNER. The mode of infection is an essential problem always arising during epidemics. Means of prevention to be adopted correspond, as far as practicable, to the manner of infection. The prevailing view is that the virus of poliomyelitis enters and leaves the body in the nasopharyngeal secretions. This view is based (1) on the presence of virus in these secretions from patients and healthy carriers; and (2) the ready infection of monkeys by way of the nasal membranes. Other modes of infection may exist. One which has often been considered is the carriage of the virus by lower animals living in close relation to man. Wild rats and mice caught in the severely affected districts of Brooklyn, New York, during the epidemic of 1931, were free of virus, and virus introduced into them experimentally survived only a few days. The gastro-intestinal tract in monkeys is traversed by the virus either not at all or with great difficulty. Monkeys resisting virus feedings respond to nasal inoculation. The recovery of virus from the contents of the intestine and the mesenteric lymph nodes in man has been effected very rarely. The conclusions drawn from these observations are that the virus is confined to the human host, and its main portal of entry into and escape from the body is by way of the nasal membrane, in which structure it selects the nerves of smell, passing along these to and from the brain and spinal cord. Specific prevention of poliomyelitis in monkeys can be accomplished by the use of blood serum from recovered human beings and from monkeys given the disease experimentally. Certain adult persons, not known to have had poliomyelitis, also yield protective blood sera. This prevention, by passive transfer of immunity, is, however, effective for relatively brief periods of time. An enduring active immunity can be produced in monkeys through inoculations of virus. The methods hitherto employed have been uncertain in their action, for in exceptional instances, they have been followed by paralysis. Active immunization has, therefore, never been undertaken in man. New experiments to be described have had for their purpose a refinement of the methods of inducing active immunity in monkeys. They have dealt also with the problem of variation of the virus under conditions of natural and artificial propagation.

The time of ovulation in the menstrual cycle: CARL G. HARTMAN (introduced by G. L. Streeter). Gynecological data point to the middle of the menstrual cycle as the time when ovulation takes place in women but indicate that ovulation is possible at any time, even during the menstrual flow. The latter conclusion is reached upon testimony which does not bear scientific scrutiny. The crucial evidence, however, is the recovery of the egg, now accomplished six times in the human and about thirty times in the monkey. In all these cases ovulation occurred between days 9 and 18 (counting the beginning of the flow as day 1). Furthermore, sixty ovulation days were determined by rectal palpation of the monkeys' ovaries; these all occurred between days 9 and 17. The average for man and monkey is about day 14.

Models showing accumulation in the steady state: W. J. V. OSTERHOUT and W. M. STANLEY. It is often stated that living cells contravene physical laws, since in the process of accumulation penetrating substances attain a higher concentration inside than outside and thus appear to diffuse inward against a gradient. As attempts to explain this by the Donnan principle have failed in the case of *Valonia* the hypothesis of the steady state has been formulated to explain what occurs. In order to see whether this hypothesis is in harmony with physicochemical laws attempts have been made to imitate its chief features by means of a model. The model consists of a non-aqueous layer (representing the protoplasmic surface) placed between an alkaline aqueous phase (representing the external solution) and a more acid aqueous phase (representing the cell sap). The model reproduces most of the important features of the hypothesis. One important feature of the hypothesis is not seen in the model: this is the exchange of HCO_3 for Cl. Experiments on this point are in progress. Equations have been developed which enable us to predict the composition of the ''artificial sap'' in the steady state.

The concentrations of uric acid, sugar and phosphates in the glomerular urine of frogs, snakes and necturi: A. N. RICHARDS, ARTHUR M. WALKER and JAMES BORDLEY, III. Existing methods for the quantitative determination of substances have been adapted to the minute amounts of fluid which can be collected by micropipettes from the renal corpuscles of lower animals. The analyses indicate that the glomerular fluid has the composition of an ultrafiltrate of the blood plasma from which it is derived.

The implantation of the ovum in Macacus rhesus as compared with man: G. L. STREETER. Attention is called to three features that characterize the embedding of the human ovum. First of these is the superficial location of the site. The ovum does not penetrate deeply into the endometrium but just barely disappears under cover of the surface epithelium. On enlarging, it at once begins to bulge into the uterine cavity. The appearance of deep implantation results from transformation of the underlying endometrium. Secondly, the primary reaction of the endometrium is localized in the immediate vicinity of the ovum. And thirdly, there is marked reaction of the vascular system directly underlying the ovum resulting in large venous sinuses which spread around the ovum so that the latter, during this period, lies in an environment of relatively stagnant blood. The hemal environment is further added to by the destructive effect of the trophoblast upon the adjacent capillary walls, resulting in extravasations which promptly fill the trophoblastic lacunae, the precursors of the intervillous spaces. In the macaque similar principles prevail, though here the picture is somewhat altered, chiefly because of temporal difference in response of the endometrium and differentiation of ovum. The two opposing sites are definitely differentiated before the attachment of the ovum is completed. As in man, however, modifications in the capillary bed and subsequent communications between it and the trophoblastic lacunae establish the foundation of an intervillous circulation. This study is being made jointly with Dr. George B. Wislocki, of the Harvard Medical School, Boston.

Heredity of otosclerosis: CHARLES B. DAVENPORT. (Read by title.)

Critical geologic features of the Hoover Dam site: CHARLES P. BERKEY. Hoover Dam, because of its unprecedented height and the consequent exceptional physical changes that will be established by such a dam and reservoir, has required greater assurance than usual of satisfactory rock foundations and other geologic conditions. The great load calls for sound support and the increased water pressure tending to develop leakage and destructive attack emphasizes the importance of good petrographic quality. There must be provision also for the handling of flood waters in emergency through tunnels of enormous size, and this raises a question concerning stability under construction and danger to the workmen. Selection of the site in Black Canyon instead of Boulder Canyon was determined largely by its more favorable geologic conditions, including depth and cross-section of the gorge. The foundation rock is sound, essentially impervious, not badly jointed, is virtually free from constituents susceptible to ready attack by water, and comparatively resistant to destructive weathering. Such a fortunate combination of natural features is seldom found in a region of so complex geologic history. The actual conditions thus far revealed at the present stage of construction tend to confirm the anticipated behavior. In addition to the special requirements at the dam site, there are equally critical features connected with the impounded water and its delivery. The heavy load of silt, tending by its accumulation in the reservoir to reduce its storage capacity; the salt deposits of the basin, tending to contaminate the water; the shifting sands of the dune belt crossed by the All-American canal, tending to obstruct its flow—all present problems that have had to be taken into account. The discussion is devoted to the relation between these geologic features and the plan and execution of the project.

1932 International Expedition to the West Indies. Marine geology: RICHARD M. FIELD (introduced by William Bowie). The purpose of the 1932 International Expedition to the West Indies was to determine whether a geological study of an oceanic area might yield results which would appreciably advance our knowledge of geological processes and subcrustal conditions. The decision to make this effort was strengthened by fundamental investigations by Dr. F. A. Vening-Meinesz in the East Indies and his 1928 expedition in the Gulf and Caribbean. The expedition, which completed its program at Miami on March 19, is also in a measure the result of a number of oceanographic investigations in the region of the Bahamas and neighboring waters, beginning with the cruise of the *Wild Duck*, directed by Alexander Agassiz, and ending with the series of Princeton expeditions initiated in 1927. The results of the 1929 expedition to the Bahamas are already in print or are in the course of publication, the latest paper being "The Microbiological Precipitation of Calcium Carbonate in the Tropical Sea." Following the 1929 expedition, it became obvious that the related problems presented by the region covered such a wide field of geological and biological research that an International Council was formed for the further investigation of these West Indian problems. Since it was felt that, at present, the fundamental question was the relation of the structure and stability of the islands to the origin, migration and alteration of the sediments which mantle their surfaces, the 1932 expedition was planned as a geophysical survey to provide further data as to the submarine topography and related subcrustal conditions affecting the local intensity of gravity. The expedition was made possible principally through the cooperation of Dr. Meinesz, the British Government, the United States Navy and the U. S. Coast and Geodetic Survey. Four thousand miles of sonic soundings have been made and sixty-six gravity stations determined (fifty-four at sea and twelve on the islands). The submarine profiles are already available, and a number of the gravity stations have been computed. Upon the completion of the isostatic reductions, a chart will be issued by the Hydrographic Office of the United States Navy which will show not only the results of the 1932 expedition but also all the geophysical data, including seismic epicenters, for the entire Gulf and Caribbean region and contiguous continental areas. It is expected that this chart will be available for distribution early this summer. The full report on the 1932 gravimetric survey (marine unit) will be published by the Hydrographic Office of the United States Navy.

The reports of the Princeton University expeditions to Patagonia: W. B. SCOTT.

Two types of sex determination in dioecious strains of maize: R. A. EMERSON. In some organisms the male is the heterogametic sex, producing two kinds of sperm, and the female is homogametic, producing only one kind of egg, with respect to sex determination. In other forms the male is homogametic and the female heterogametic. To the first group belong flies, man, certain fishes and some dioecious plants. To the second group belong moths, birds and certain fishes. Recently Jones has reported a dioecious strain of maize in which the male is the heterogametic sex. Using somewhat different material, I have synthesized two dioecious strains of maize, the male of one strain and the female of the other being the heterogametic sex. The male type used in producing these strains is what is known as barren stalk, *ba*, a simple Mendelian recessive having normal anther-producing tassels but no ear shoots. The female types employed are known as tassel-seed, producing seeds not only on the ear but also in the tassel to the exclusion of anthers. One of these, ts_1, is a simple Mendelian recessive and the other, Ts_2, is a simple dominant. These strains maintain an approximately 50–50 numerical relation between the sexes as do most dioecious species of plants and animals. Moreover, the known linkage relations of the heterozygous genetic factors of one strain make it readily possible to demonstrate typical sex linkage of certain common maize characters.

(*To be concluded*)

BOOKS RECEIVED

ABBOTT, C. G., Director. *Annals of the Astrophysical Observatory of the Smithsonian Institution.* Volume V. Pp. ix + 295. Smithsonian Institution.

CHASE, CARL T. *A History of Experimental Physics.* Pp. 195. Illustrated. Van Nostrand. $2.25.

DORDILLON, MGR. RENE I. *Grammaire et Dictionnaire de la Langue des Iles Marquises.* Pp. 446. Institut D'Ethnologie, Paris.

GADEN, HENRI. *Proverbs et Maximes Peuls et Toucouleurs.* Pp. 368. Institute D'Ethnologie, Paris.

HARDING, T. SWANN. *The Joy of Ignorance.* Pp. 369. William Godwin. $3.00.

JASTROW, JOSEPH. *The House that Freud Built.* Pp. x + 293. Greenberg.

LEENHARDT, MAURICE. *Neo-Calédoniens.* Pp. 514. Institut D'Ethnologie, Paris.

MITTASCH, A. and E. THEIS. *Von Davy und Döbereiner bis Deacon.* Pp. 278. 16 plates. Verlag Chemie, G.M.B.H., Berlin.

SCHMIDT, JOHANNES. *Dana's Togt Omkring Jorden, 1928–1930.* Pp. 308. 278 figures. Gyldendalske Boghandel, Kobenhavn.

SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH. *Tuberculosis in South African Natives.* Vol. V., No. XXX. Edited by the Director. Pp. 427. Illustrated. The Institute, Johannesburg.

VAN VLECK, J. H. *The Theory of Electric and Magnetic Susceptibilities.* Pp. xii + 384. 16 figures. Oxford University Press. $7.50.

SCIENCE

VOL. 75 FRIDAY, MAY 27, 1932 No. 1952

American Association for the Advancement of Science:
Preliminary Announcement of the First Syracuse Meeting: DR. CHARLES F. ROOS 547

Obituary:
John Wesley Young: PROFESSOR VIRGIL SNYDER. *Recent Deaths* 554

Scientific Events:
Primitive Areas in the Washakie National Forest in Wyoming; The Annual Review of Biochemistry; The Sigma Xi Chapter of the University of Illinois College of Medicine; National Research Fellowships in the Biological Sciences; The American Academy of Arts and Sciences; Portrait of Professor Huber 556

Scientific Notes and News 558

Discussion:
The Possible Chemotactic Effect of the Salivary Secretions of Certain Insects upon Microfilariae: PROFESSOR CHAS. F. CRAIG. *Ainu Pits in the Kurile Islands:* MILES L. PEELLE. *The Jesuit Fourth Vow:* REVEREND JAMES B. MACELWANE. *Indexes of Biological Abstracts:* PROFESSOR C. E. MCCLUNG 561

Scientific Apparatus and Laboratory Methods:
The Use of Color Filters in Colorimetric Analysis: R. H. HAMILTON, JR. 563

Special Articles:
Probability of the Presence of a Sex Antagonistic Substance in Urine: DR. CASIMIR FUNK and PETER P. ZEFIROW. *Berries Rich in Calcium:* DR. E. YANOVSKY, E. K. NELSON and R. M. KINGSBURY 564

The National Academy of Sciences:
Papers Presented at the Washington Meeting 566

Science News 10

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRELIMINARY ANNOUNCEMENT OF THE FIRST SYRACUSE MEETING

Edited by Dr. CHARLES F. ROOS

PERMANENT SECRETARY

SEVENTEEN scientific organizations and most of the fifteen sections of the American Association will hold scientific sessions in Syracuse during the period from June 20 to June 25. This meeting, which will be the first meeting of the association in Syracuse, is expected to be remembered for important symposia and for the opportunities offered for excursions and field trips for geologists, botanists, zoologists, chemists, statisticians, physicians and others who may attend.

Syracuse University, which will be the host institution, is cooperating with the local chamber of commerce and other local institutions to make this meeting a successful one. A short article giving some interesting information concerning the host institution and the Syracuse hotels appeared in SCIENCE for April 1.

LOCAL COMMITTEES FOR THE SYRACUSE MEETING

The following are the members of the local committees who are busy with plans for the summer meeting of the American Association for the Advancement of Science:

STEERING COMMITTEE

Honorary chairman, Chancellor Charles W. Flint, chancellor of Syracuse University.

General chairman, Dr. Hugh P. Baker, dean of the New York State College of Forestry.

Secretary, Dr. A. L. Elder.
Dr. W. L. Bray, dean of the Graduate School.
Dr. K. C. Leebrick, dean of the College of Liberal Arts.
Dr. L. C. Mitchell, dean of the College of Applied Science.
Dr. W. E. Mosher, director of the School of Citizenship and Public Affairs.
Dr. C. L. Raper, dean of the College of Business Administration.
Dr. H. G. Weiskotten, dean of the College of Medicine.
Dr. H. S. Ganders, dean of Teachers College.

STEERING COMMITTEE

The city of Syracuse is taking a very active interest in the arrangements for the guests of the university at the summer meeting. The following citizens of Syracuse are cooperating on the steering committee and assisting in making such plans as are necessary to unite together the efforts of the down-town district and the university:

Mr. W. L. Hinds, manufacturer.
Mr. Bert E. Salisbury, manufacturer and trustee of Syracuse University.
Mr. George H. Bond, lawyer and member of the New York State University Board of Regents.
Judge Frank H. Hiscock, former chief judge of the New York State Court of Appeals.
Mr. Horace White, former governor of New York State.
Mr. H. W. Smith, manufacturer.
Mr. Samuel H. Cook, manufacturer.
Mr. W. H. Kelley, banker, and Democratic State committeeman from Onondaga County.

CHAIRMAN OF SUBCOMMITTEES

Public Lectures: Dr. W. E. Mosher.
Meeting: Mr. Keith Kennedy.
Exhibits: Professor Ernest Reed.
Housing: Dr. Leslie Bryan.
Excursions: Professor S. P. Poole.
Publicity: Dr. Burgess Johnson.
Finance and Publication: Dr. D. Walter Morton.
Entertainment and Reception: Dr. H. L. Butler, dean of the College of Fine Arts.

LOCAL REPRESENTATIVES

Section A (*Mathematics*), Professor A. D. Campbell.
Section B (*Physics*), Professor R. A. Porter.
Section C (*Chemistry*), Professor R. S. Boehner.
Section D (*Astronomy*), Mr. R. W. Shaw, Physics Department, Cornell University.
Section E (*Geology and Geography*), Professor G. B. Cressey.
Section F (*Zoological Sciences*), Professor W. M. Smallwood.
Section G (*Botanical Sciences*), Professor H. F. A. Meier.
Section H (*Anthropology*), Professor D. G. Haring.
Section I (*Psychology*), Professor Ernst Thelin.
Section K (*Social and Economic Sciences*), Professor F. G. Crawford.
Section L (*Historical and Philological Sciences*), Professor R. V. Harlow.
Section M (*Engineering*), Professor E. F. Church.
Section N (*Medical Sciences*), Dr. M. S. Dooley.
Section O (*Agriculture*), Dean R. L. Nye, dean of the College of Agriculture.
Section Q (*Education*), Professor W. T. Melchior.

Any correspondence for the Local Committee pertaining to any of the sections should be addressed to the local representative. General correspondence for the Local Committee should be sent to Dean Baker or Dr. Elder.

Arrangements are being made through the Teachers College to furnish assistance for those who desire care of children. The Boy Scouts and the Girl Scouts are planning to assist in this work.

No doubt there will be many who will plan to drive to Syracuse, and excellent provisions are being made for those who are driving and camping. Camping facilities will be available at Kirk Park near the university campus. The site is a beautiful one for camping, and provisions for fuel, water, etc., will be made. Guards will be provided around the camp at all times during convention week.

Mr. Howard Viets has charge of outdoor recreation and has made arrangements with various golf courses for the convention week. Those who desire to play tennis, go swimming, or fishing, will find that by convention time Mr. Viets will have a list of all places available for such recreation. Greatly reduced rates at the golf courses have been obtained.

Most of the scientific sessions will be held at Syracuse University. The general program of the meeting will be available on Monday morning, June 20, at 9:00 A. M. and throughout the week at the association's registration office in the Men's Gymnasium. This book will be supplied free to all members of the association who register and may be purchased by others. Any person who does not attend the meeting may have a free copy of the program sent by mail if a request is addressed to the permanent secretary's office, Smithsonian Institution Building, Washington, D. C.

GENERAL SESSIONS

The Syracuse meeting will be held under the presidency of Dr. John Jacob Abel, of the Johns Hopkins University, who is widely known for his valuable contributions to pharmacology and chemistry. The retiring president this year is Dr. Franz Boas, of Columbia University. Dr. Boas is frequently called the dean of American anthropologists.

General lectures will be given by eminent scientists, one on each of the five nights of the meeting period, and one or more on each afternoon. Professor Edward L. Thorndike, of Columbia University, will deliver a general lecture on the subject "The Psychology of Capital." On Tuesday evening, Dr. J. O. Perrine, of the Bell Telephone Laboratories, will lecture on "Television." On Wednesday evening, Dr. W. F. G. Swann, of the Bartol Research Foundation, will give an illustrated lecture on "Cosmic Rays." Dr. Swann plans to perform one or more experiments on cosmic rays during his lecture. A general lecture which is planned to be on some phase of public health will be particularly appropriate at Syracuse, since June 20 will be the one hundredth anniversary of the founding of the Syracuse Department of Public Health. At an evening session, Professor Henry Crew, of Northwestern University, will give a general address on "The Relation of Science to International Expositions." In particular Dr. Crew will talk about some of the features of the Century of Progress Exposition at Chicago in 1933 which will appeal particularly to scientists. Other general addresses will be given as follows: "Refuse Ideas and Their Disposal," by Professor Dixon R. Fox, of Columbia University; "A Layman's Introduction to Higher Mathematics," by Professor Walter B. Carver, of Cornell University; "The Toxicity of Inorganic Substances," by Professor Rodney H. True, of the University of Pennsylvania, and "Some Traits of Society in the South Sea Islands," by Professor Richard Thurnwald of Yale University. It is expected that two or three more popular addresses will be added to the general program of the association.

The Syracuse reception will be held on Monday evening following the opening lecture. All members of the association who register will be furnished free tickets to the reception for themselves and for members of their immediate family who register. Nonmembers of the association may attend the reception by joining at Syracuse on payment of the entrance fee and dues for one half year, or by becoming associates for the meeting. The associate fee for the Syracuse meeting is $2.50.

FIELD EXCURSIONS

AT the June meetings of the Association for the Advancement of Science, advantage is to be taken of the summer weather to visit as many parts of the state as possible. Section E is especially planning for its members to do a large part of their work in the field.

The rich variety of topographic and physiographical forms that Central New York affords will be looked over as thoroughly as possible. On Wednesday, June 22, the afternoon will be devoted to a field trip through the great drumlin belt near the Finger Lakes and to the Jamesville plunge basins. Stops will be made also in the Tully Moraine, certain of the numerous cross channels and some of the water falls and places of glacial or topographic interest in the lake region.

Several trips will be conducted on Thursday afternoon, after a morning devoted to papers on Paleozoic stratigraphy. These will be to many of the classic exposures of the Silurian and Devonian for which Central New York is so well known. On these trips opportunity will be afforded for those who desire to make such collections as they wish.

The final day, Friday the 24th, will be devoted to an all-day excursion through the Mohawk valley and into the older rocks of the Adirondack region. This will interest the geographer as well as the geologist, for it will give a broad view of land utilization and the adaptation of trade routes to topography in the famous Mohawk Corridor.

Sections F and G (Zoology and Botany) are also planning an extensive and interesting program of field excursions. One of these will be to the Green Lakes at Jamesville and another to the wild life preserve near McLean. A third all-day trip is to afford opportunity to visit the bogs and marl ponds at Junius, southwest of Syracuse.

On all these trips, lunches and suppers will be provided where necessary in the field, and the entire cost of all of them will be held strictly to a minimum. All who attend the meetings of the association or associated societies are invited to take advantage of these excursions. It is desired by all the local representatives of the sections as well as the chairman of the committee on excursions that those who attend the meetings and contemplate participating in any of these excursions inform the local committee, at least not later than at the time of registering.

NOTICES FOR THOSE PLANNING TO ATTEND

Those who plan to attend this meeting should engage hotel rooms at once, addressing the hotels. Whether the room desired is to be occupied by one or two persons should be stated, also the approximate price which the applicant wishes to pay and the date on which the room is to be occupied. Approved hotels are the following: Hotel Syracuse (general headquarters), Onondaga Hotel, Yates Hotel, Jefferson-Clinton Hotel, Mispah Inn, Hotel Hilton, Hotel Wood, Truax Hotel and Kirk Hotel. An article containing more complete hotel information appeared in SCIENCE for April 1, 1932.

When purchasing your railway ticket to Syracuse, be sure to secure a certificate for the Syracuse meeting of the American Association for the Advancement of Science and bring the certificate with you to the registration offices for the meeting.

REDUCED RAILWAY RATES

Reduced railway rates for the Syracuse meeting, by the standard certificate plan, have been granted by all the railway passenger associations in the United States and Canada, but a few companies, listed below, have not granted reduced rates. The round-trip fare by this plan is one and one half times the regular one-way fare.

Tickets to Syracuse by the standard certificate plan are to be purchased within time limits as follows: June 16 to 22, inclusive, for Canadian Eastern lines, Central lines, New England lines, Southeastern lines and Trunk lines. For Western and Transcontinental lines the inclusive dates are June 13 to 19 from California; June 14 to 20 from Arizona, British Columbia, Idaho, Montana, Nevada, Utah, Washington and Oregon (except via California); June 13 to 19 from Oregon (via California); June 15 to 21 from New Mexico, Wyoming and Colorado (except Julesburg); June 16 to 22 from Julesburg, Colorado, and from Illinois, Iowa, Kansas, Manitoba, Minnesota, Missouri, Nebraska, northern Michigan, North Dakota, South Dakota and Wisconsin. For the Southeastern lines the inclusive dates are June 15 to 21 from Oklahoma and Texas and June 16 to 22 from Arkansas, Kansas, Louisiana and Missouri; also Memphis, Tennessee, and Natchez, Mississippi. For the Canadian Western lines the inclusive dates are June 14 to 20 from British Columbia; June 15 to 21 from Alberta; June 16 to 22 from Saskatchewan, Manitoba, and Ontario.

The following Southwestern lines do not offer reduced fares on the certificate plan: Arkansas and Louisiana Missouri Railway, Fort Smith and Western Railroad, Graysonia, Nashville and Ashdown Railroad, Louisiana, Arkansas and Texas Railway, Oklahoma City-Ada-Atoka Railway, Wichita Falls and Southern Railway, Kansas, Oklahoma and Gulf Railway, National Railways of Mexico and the Midland Valley Railway.

Persons residing in the regions of reduced rates (almost all the United States and Canada) should each purchase a first-class, full-fare, one-way, through ticket to Syracuse, being sure to secure a certificate on "Standard Certificate Form," reading for the "Syracuse meeting of the American Association for the Advancement of Science and Associated Societies." A receipt is not required and will not be used.

Persons residing outside the regions of reduced rates should each purchase a round-trip ticket to the nearest station issuing through tickets to Syracuse and situated within the region of reduced rates. On arrival at that station a one-way ticket to Syracuse and a certificate, as directed in the preceding paragraph, should be secured.

Every one should register immediately upon arrival at Syracuse, at the registration offices for the meeting, in the Men's Gymnasium, Syracuse University. Be sure to fill in all blanks on the registration card and leave the card at the registration desk, where you will receive a numbered identification card, which will be receipted for the registration fee paid. (See Registration, below.) Then leave your railway certificate at the validation desk, being sure that the identification card (which you keep) is there marked to show that you have deposited a certificate. Your certificate will subsequently be endorsed by the association and then validated by the agent of the transportation companies. Call for it later at the validation desk, where you left it, presenting your identification card.

Unvalidated certificates will not be honored for the purchase of return tickets and unendorsed certificates can not be validated. Registration is therefore necessary in order to have a railway certificate validated. Each person registering is entitled to the validation of his own certificate.

For the return trip, railway agents at Syracuse will honor any properly endorsed and validated certificate if presented at least thirty minutes before the scheduled time of departure of the train for which it is to be used. Each person presenting an endorsed and validated certificate may purchase a continuous-passage, one-way, return ticket for one half of the regular fare, by the same route as that followed on the trip to Syracuse. Certificates may be validated from June 21 to 23. The last date on which return tickets may be purchased is June 29.

Attention is called to summer-tourist fares which will be in effect at the time of the Syracuse meeting. Short-limit summer tickets are limited to 30 days, including date of sale, and are somewhat less in price than season-limit tickets which are good for the return trip until October 31. It is advisable to obtain further information from the railroad ticket agent about these special fares.

THE AMERICAN ASSOCIATION PRESS SERVICE

By Austin H. Clark

The prestige of any organization depends upon how widely and how favorably it is known to the public at large. The general public gets its information regarding such organizations as the association entirely from the daily press.

It is therefore incumbent upon the members of the association to see that the representatives of the press are provided at each meeting with the material necessary for the preparation of accurate and adequate accounts of the proceedings.

Those who are on the program of the Syracuse meeting are requested to send as soon as possible to Austin H. Clark, Director of the Press Service, A. A. A. S., Smithsonian Building, Washington, D. C., *two* copies of their complete papers, and also *two* copies of an abstract of about 500 words in length.

Abstracts alone are, generally speaking, of relatively little value. They serve to call attention to the points in the paper which are new, or which in the opinion of the author are of special interest.

But very often the points of greatest popular interest in a paper are not those that would be mentioned in an abstract prepared by the author. Many facts entirely commonplace to one specializing in science are entirely new and most interesting to the public at large.

Another thing is that abstracts are so short that when used for press purposes they must often be run almost word for word. This means that little latitude is permitted the representatives of the various press services and individual papers in preparing their stories, which are therefore of necessity very much alike.

With the complete copies of the papers before them, the press representatives can write accounts of the addresses that will be far more satisfactory to all concerned.

Promptness in sending in copies of the papers to the Press Service is most desirable. If the copies of the papers are available well in advance of the meeting the representatives of the press can go over them in their spare time. They are thus enabled to study them carefully and, as a result, to write from them much better stories than if their work had to be done under pressure in a limited time.

In many cases papers that would be quite useless for news purposes if received at the last minute are found to be of considerable interest if they are available a sufficient length of time in advance to permit of careful study.

Copies of papers sent to the Press Service are for press use only. They are regarded as confidential and are not seen except by the Press Service and the press representatives.

After the meeting they are retained and are thoroughly examined for possible feature or other articles, or for the preparation from them of short items of popular interest.

It is not practicable to return to the authors material sent to the Press Service. It is assumed that papers sent in for press use are extra copies that can be spared.

The Press Service is concerned only with the relations between the association and the press. The titles of papers and all other information concerning them should be sent to the permanent secretary. Only material having to do directly with publicity should be sent to the Press Service.

SCIENTIFIC SESSIONS OF SECTIONS AND SOCIETIES

Note.—Names of organizations are arranged in the order of association sections. Each affiliated society has one or two representatives in the association council as indicated by one or two asterisks before the society name. A cross before a name indicates that the society is associated but not affiliated. Societies which have neither asterisks nor crosses before their names are not associated but have been especially invited to meet with the association on this occasion. The vice-president, retiring vice-president and secretary are named for each association section, the president and secretary are named for each society and the council representatives for the affiliated societies. Dates of meetings when supplied are to be read as inclusive. For more complete information the General Program of the meeting should be consulted. This will be available at the registration desk on Monday morning, June 20.

A. Mathematics.

A-1——Section A of the Association. June 22–23.
Vice-president, Howard H. Mitchell; *retiring vice-president*, Earle Raymond Hedrick; *secretary*, Charles N. Moore.

Sessions for the reading of several one-hour addresses are planned for Tuesday and possibly Wednesday of the meeting week. Professor W. A. Hurwitz, of Cornell University; Professor H. M. Gehman, of the University of Buffalo, and Professor J. A. Shohat are expected to give addresses on work in which they are particularly interested at this time. Professor W. B. Carver, of Cornell University, will deliver a general address before the association on "A Layman's Introduction to Higher Mathematics." Professor Earl R. Hedrick, of the University of California at Los Angeles, will participate in a symposium on "General Educational Problems" with Professor E. L. Thorndike, Professor J. G. Needham and other men of eminence. Members of Section A and other mathematicians are specially invited to attend the meetings of Section K (Economics, sociology and statistics) and of the Econometric Society. (See the announcement of Section K.)

B. Physics.

B-1——Section B of the Association. June 22.
Vice-president, D. L. Webster; *retiring vice-president*, Bergen Davis; *secretary*, A. L. Hughes.

On Wednesday evening, June 22, Dr. W. F. G.

Swann, president of the American Physical Society, will deliver a general illustrated lecture on "Cosmic Rays." (See General Sessions.) On Friday evening, Professor Henry Crew, of Northwestern University, will speak on "The Relation of Science to International Expositions." Since the affiliated American Physical Society is meeting in New Haven during the same period as the association's meeting, no technical sessions are planned by Section B, but physicists are invited to attend the symposium on the "Effect of X-rays on Biological Life." (See Section C.)

C. Chemistry.

C-1——Section C of the Association.
Vice-president, F. C. Whitmore; *retiring vice-president*, C. A. Browne; *secretary*, R. C. Funson.

C-2—**American Chemical Society (Regional Meeting of New York Sections).
Chairman, C. C. Spencer; *secretary*, N. E. Artz.

The New York Sections of the American Chemical Society will hold their annual regional meeting jointly with Section C at Syracuse, probably on Friday and Saturday. More than thirty papers have already been placed on the program. A joint session with the biologists and the physicists, for a symposium on "The Effect of X-Rays on Biological Life," is planned for Friday morning. In addition to these programs it is planned to have one or more general lectures on chemistry.

D. Astronomy.

D-1——Section D of the Association.
Vice-president, P. W. Merrill; *retiring vice-president*, J. H. Moore; *secretary*, Philip Fox.

During the meeting period astronomers are expected to be very busy preparing for the eclipse which will occur on August 31. As a result it seems inadvisable for Section D to arrange a program.

E. Geology and Geography.

E-1——Section E of the Association. June 21-24.
Vice-president, W. H. Hobbs; *retiring vice-president*, D. W. Johnson; *secretary*, K. F. Mather.

On Tuesday afternoon, June 21, Section E plans a joint session with Section M (Engineering) for a symposium on "Aerial Photographic Surveying and Mapping" (see Section M). On Tuesday, Section E will join Section O for a symposium on "Land Use." On the morning of June 23 a session will be held devoted to "The Paleozoic Stratigraphy of New York." In the afternoon there will be an excursion to points of special stratigraphic interest. On Wednesday morning, June 22, a symposium will be held on "Local Physiography, Including Glacial Problems." A field trip to be devoted to a study of physiography is also planned for Thursday. An all-day field trip is planned for Friday, June 24, to the Mohawk Valley and possibly to the Adirondacks.

F. Zoology.

F-1——Section F of the Association.
Vice-president, Charles Zeleny; *retiring vice-president*, R. W. Hegner; *secretary*, G. T. Hargitt.

F-2—**Ecological Society of America.
President, G. E. Nichols; *secretary*, Raymond Kienholz; *council representatives*, W. C. Allee and G. P. Burns.

A session devoted to a symposium on "The Effect of X-Rays on Biological Life" is planned for Friday, June 24. Members of Section F are invited to send titles of papers which they are to present to the secretary of the section. Several half-day excursions to Junius, Jamesville and Selkirk are planned for June 21, 22 and 23. On these occasions a number of informal talks on local fauna will be given.

The Ecological Society of America plans meetings for the reading of papers and a number of field trips.

G. Botany.

G-1——Section G of the Association.
Vice-president, H. L. Shantz; *retiring vice-president*, E. D. Merrill; *secretary*, S. F. Trelease.

G-2—**Botanical Society of America.
President, G. J. Peirce; *secretary*, S. F. Trelease; *council representative*, I. F. Lewis.

G-3—**Torrey Botanical Club.
President, E. W. Sinnott; *secretary*, F. T. McLean; *council representatives*, D. T. MacDougal and B. O. Dodge.

G-4——†American Fern Society.
President, W. R. Maxon; *secretary*, C. S. Lewis.

G-5——Syracuse Botanical Club.

As customary, the programs for Section G will be arranged by the associated societies. Half-day field trips are planned for June 21 and 22 and an all-day field trip for June 23.

The Botanical Society of America will hold a meeting along the lines usually followed in its summer meetings. There will be no program for the reading of papers. Meetings will be largely field trips with a few demonstrations and perhaps round tables.

The American Fern Society plans a number of field trips.

H. Anthropology.

H-1——Section H of the Association.
Vice-president, C. H. Danforth; *retiring vice-president*, W. K. Gregory; *secretary*, C. E. Guthe.

A symposium on "Far Eastern Problems" is planned with Professor E. S. C. Handy and Professor Richard Thurnwald taking part.

I. Psychology.

I–1——Section I of the Association.
Vice-president, W. S. Hunter; *retiring vice-president*, H. S. Langfeld; *secretary*, J. E. Anderson.
I–2——Upper New York Psychologists.

The Upper New York Psychologists plan a two-day meeting in cooperation with Section I of the Association. In addition several symposia are being organized. A joint session with Section K on Tuesday afternoon will be devoted to a symposium on "Social Statistics." Professor L. L. Thurstone will speak at this session. Other symposia are planned on "Mental Hygiene" and "Industrial Psychology."

Professor E. L. Thorndike, of Columbia University, will deliver an address at a general evening session of the association on "The Psychology of Capital." Sessions of interest to some psychologists will be held by Section K, in connection with symposia on "Demand and Supply."

K. Economics, Sociology and Statistics.

K–1——Section of the Association.
Vice-president, W. F. Ogburn; *retiring vice-president*, G. C. Evans; *secretary*, Harold Hotelling.
K–2——*The Econometric Society.
President, Irving Fisher; *secretary*, C. F. Roos; *council representative*, W. A. Shewhart.

On Thursday afternoon Section K will meet jointly with the Econometric Society, for a symposium on "Money and Capital," at which Professor Irving Fisher will preside. Dr. Carl Snyder, economist of the Federal Reserve Board; Professor T. N. Carver, of Harvard University, and others will take part in this symposium. In this connection it should be noted that Professor Edward L. Thorndike, of Columbia University, will deliver a general address at an evening session of the association on the subject "The Psychology of Capital."

Tuesday morning Section K will join with the Econometric Society for a symposium on "Demand and Supply." Papers of mathematical interest will be given at this session. On Tuesday afternoon Section K will hold a joint session with Section I for a symposium on "Social Statistics," at which time Professor L. L. Thurstone, of the University of Chicago, will deliver an address.

On Wednesday morning Section K and the Econometric Society will hold a session for papers on mathematical statistics. This session will be followed by a report on collegiate mathematics needed in the social sciences. On Wednesday afternoon sessions for additional papers on "Demand and Supply" will be held at Cornell University. An inspection of the statistical laboratory of Professors Warren and Pearson will follow.

L. Historical and Philological Sciences.

L–1——Section L of the Association.
Vice-president, W. G. Leland; *retiring vice-president*, W. B. Munro; *secretary, Committee on History of Science*, Joseph Mayer; *secretary, Committee on Linguistics*, Leonard Bloomfield.
L–2——New York Historical Association.
President, D. R. Fox; A. C. Flick, *corresponding secretary*.

Sessions of the New York Historical Association are being organized by Professor Dixon R. Fox, of Columbia University, for Tuesday. It is hoped that in addition to these programs a session devoted to the "History of Medical Science in its Relation to Public Health" can be organized to commemorate the one hundredth anniversary of the founding of the Syracuse Department of Public Health.

Following the Tuesday afternoon session, Professor Dixon R. Fox will deliver a general address before the association on the subject "Refuse Ideas and Their Disposal."

M. Engineering.

M–1——Section M of the Association.
Vice-president, D. C. Jackson; *retiring vice-president*, D. S. Kimball; *secretary*, N. H. Heck.

On Tuesday morning Section M will hold a session for a symposium devoted to "Industrial Engineering." At this session Dr. D. A. Laird, Dr. Allan Mogenson, Dr. Myron Lee and others will give addresses. On Tuesday afternoon Section M will meet jointly with Section E (Geology and Geography) for a session devoted to "Aerial Photographic Surveying and Mapping." Dr. H. L. Cooke, of Princeton University, will take part in this symposium.

On Tuesday evening, Dr. J. O. Perrine, of the American Telephone and Telegraph Company, will deliver a general address on "Television."

Several excursions and industrial trips are planned for members of Section M attending the meetings.

N. Medical Sciences.

N–1——Section N of the Association.
Vice-president, W. H. Park; *retiring vice-president*, H. T. Karsner; *secretary*, W. W. Cort.
N–2—**American Society of Bacteriologists (Central New York Branch).
N–3—**Society for Experimental Biology and Medicine (Western New York Branch).

N-4—**American Roentgen Ray Society.
President, Leopold Jaches; *secretary*, E. P. Pendergrass; *council representative*, Donald Childs.
N-5——Onondaga County Medical Society.
N-6——Syracuse Academy of Medicine.

The program of Section N and its associated and invited societies promises to be much better than usual. Sessions will begin on Tuesday afternoon with a program arranged by Section N and will continue through Friday morning.

Sessions of the American Society of Bacteriologists are planned for Thursday morning and afternoon and Friday morning.

The program of the Society for Experimental Biology and Medicine will consist of sessions devoted to miscellaneous contributed papers and to other sessions for the reading of papers by invited speakers.

It is planned also to have an authority on public health deliver one of the general evening lectures and to devote a session to the history of medical science in its relation to public health. These sessions are planned to commemorate the 100th anniversary of the founding of the Syracuse Department of Public Health. A cholera epidemic was directly responsible for the founding of this institution.

O. Agriculture.

O-1——Section O of the Association.
Vice-president, J. H. Gourley; *retiring vice-president*, C. G. Williams; *secretary*, P. E. Brown.
O-2—**American Society of Agronomy (Northeastern Section).
Secretary, M. H. Cubbon.

Section O plans meetings on Tuesday devoted to symposia on "Land Use." It is proposed to consider the task of putting the different classes of land to their proper uses, to focus attention to the idle land situation and to develop a better understanding of the whole subject of land in its relation to human affairs. Special reports will be presented on the results of Land Economic Surveys that have been in progress in several states during the past decade. Among the speakers will be Dr. Jacob G. Lipman, Dr. G. F. Warren, Dr. Henry G. Knight, Dr. Charles L. Roper, Dr. E. P. Weaver, Dr. Joseph S. Illick, Mr. Franklin D. Roosevelt, and Mr. L. R. Schoenmann. The session on Tuesday morning will be held jointly with Section E (Geology and Geography). The American Society of Agronomy will hold meetings in Geneva on Wednesday and in Ithaca on Thursday. Dr. U. P. Hedrick will deliver an address at Geneva on Wednesday morning on the subject, "Fifty Years of Research at Geneva." Following a tour of the laboratories, papers will be given by H. J. Conn, R. W. Hofer, H. B. Tukey, M. T. Munn, C. B. Sayre, J. G. Horsfall and Richard Wellington. At Ithaca addresses will be given by Cornelius Betten, T. L. Lyon, J. A. Bizzell, R. A. Emerson and R. G. Wiggans. Following an inspection of the field experiments of the departments of agronomy and plant breeding at Cornell a picnic supper will be held at Enfield Glen.

Q. Education.

Q-1——Section Q of the Association.
Vice-president, S. A. Courtis; *retiring vice-president*, Ernest Horn; *secretary*, W. L. Uhl.

Section Q plans to hold a number of sessions devoted to discussions of general education problems by men of national prominence. Dr. Edward L. Thorndike, Dr. J. G. Needham, Dr. E. R. Hedrick and others have indicated that they will participate in these discussions. Dr. Thorndike will deliver a general evening lecture using the title "The Psychology of Capital."

OBITUARY

JOHN WESLEY YOUNG

FROM time to time we are called upon to take an inventory, and to adjust ourselves as best we can to new and unexpected circumstances.

Such a necessity arose when, on February 17, 1932, the notice was flashed across the country that John Wesley Young was dead.

He was born at Columbus, Ohio, November 17, 1879, but spent much of his childhood and early youth, 1889–1895, at Baden Baden where his father was American consul. His mother, of French and German ancestry, was born in Paris. Probably these facts account for the linguistic skill and felicity of the son. He graduated from Ohio State University in 1899, and then went to Cornell University where he completed his work for the doctorate in 1903, but on account of illness did not take his examination until 1904. While at Cornell he was not only an excellent student, but participated eagerly in various activities, especially in the newly founded graduate club, and had a wide circle of friends, from various walks of life. He was assistant at Cornell, 1902–1903; instructor at Northwestern, 1903–1905; preceptor at Princeton, 1905–1908; University of Illinois, 1908–1910, and was made head professor at the University of Kansas, 1910. The following year he was called to Dartmouth College, where he continued throughout his life.

The main feature of Young's activity was the breadth of his interest. He was receptive and sympathetic to any appeal that was genuine and sincere, had no respect for pomp and display, and was helpful and cooperative in every honest endeavor.

The main contributions may be divided into three general categories, (a) research, (b) teaching, (c) organization. (a) His first interest was in groups, but rapidly widened to include geometry and particularly foundations of mathematics. The most important are (1) his thesis on automorphis functions, (2) General theory of approximations by functions involving a given number of arbitrary parameters, the (3) Fundamental concepts of algebra and geometry (Macmillan, 1911), and the monumental work on Projective Geometry (Ginn and Company, 1910) with Professor Veblen, besides a number of other important articles in various mathematical periodicals. (b) In the teaching of mathematics he was always intensely interested and active; besides his uninterrupted support of the Mathematical Association of America as member of the council, vice-president and president, he was chairman of the National Committee on Mathematical Requirements. This work took much of his time and energy for eight years and resulted in the appearance of a volume of 650 pages which will exercise a profound influence on the teaching of elementary mathematics for many years. In this connection he also exercised a helpful influence as editor of mathematical texts for two important publishers. He also served as chief examiner in mathematics for the College Entrance Examination Board for two years, and cooperated in several far reaching innovations. (c) During the last few years the financial status of the Association and of the American Mathematical Society has demanded a great deal of careful study. Professor Young was appointed chairman of the Committee on Funds for both organizations and had already brought considerable order and system into the situation and had plans for future development that promised definite relief.

An active and fruitful service of over a quarter of a century has closed, and a cherished personality has become a memory. May those who are still active receive sufficient inspiration from his efforts to continue with the same endeavor.

VIRGIL SNYDER

RECENT DEATHS

GEORGE SYLVANUS MOLER, professor emeritus of physics at Cornell University and co-builder of the first commercial dynamo operated in the Western Hemisphere, died on May 20. He was eighty-one years old and had retired from active service in 1917.

DR. THOMAS H. GRONWALL, associate in physics at Columbia University, author of many papers on mathematics and the applications of mathematics in engineering and physics, died on May 9, in his fifty-fifth year.

BRIGADIER GENERAL WILLIAM BARCLAY PARSONS died on May 10, at the age of seventy-three years. Dr. Parsons was a member of the engineering staff in charge of the construction of the Panama Canal and was the builder of the Cape Cod Canal. He had been chairman of the board of trustees of Columbia University since 1917. He was also a trustee of the New York Public Library and of the Carnegie Institution of Washington.

DR. CHARLES W. RICHMOND, associate curator of birds at the National Museum, died on May 17, at the age of sixty-three years.

HARRY H. BARROWS, assistant chief of the Bureau of Agricultural Engineering of the U. S. Department of Agriculture, died suddenly on May 3.

DR. R. BISHOP CANFIELD, since 1904 chief otolaryngologist of the University of Michigan Hospital and authority on the surgery of the ear, nose and throat, has been fatally injured in an automobile accident.

DR. JOHN R. MINEHART, dean of the School of Pharmacy of Temple University, Philadelphia, died on May 10, at the age of forty-four years.

THE death is announced at the age of forty-four years of John Berdan Charlesworth, research associate in African ethnology at the Peabody Museum of Harvard University. Mr. Charlesworth held the Anthony Wilkins Memorial Studentship of the University of Cambridge. Under his fellowship, and jointly for the Peabdy Museum, Mr. Charlesworth had completed a two years' intensive study among the Basukuma, a Bantu tribe in Tanganyika Territory, Africa, south of Lake Victoria. It was on the return journey from this research that he died at sea of black-water fever. His collections and notes will go to the Peabody Museum.

THE death is announced of Sir W. Watson Cheyne, past-president of the Royal College of Surgeons of England, and consulting surgeon to King's College Hospital.

THE death is announced at the age of seventy-nine years of Charles Debierre, professor of anatomy at the Lille Medical School.

SCIENTIFIC EVENTS

PRIMITIVE AREAS IN THE WASHAKIE NATIONAL FOREST IN WYOMING

THE Forest Service announces the formal approval and designation of two primitive areas within the Washakie National Forest in Wyoming. These will be known as the Glacier and the Stratified Primitive Areas, and contain 108,500 and 147,000 acres, respectively. The latter-named tract is situated in the extreme northern part of the forest, in a country characterized by broad flat-topped plateaus, cut away in places by deep, narrow canyons.

The Glacier Primitive Area lies on the east slope of the Continental Divide, or Wind River Range, near the central part of the Washakie Forest, and adjoins on the east the Bridger Primitive Area, containing 138,000 acres of land on the western slope of the Continental Divide. The two combined contain nearly 250,000 acres of rugged, mountainous land that can scarcely be surpassed for scenic grandeur and beauty.

Glacier Primitive Area is within an extremely rough and rugged region, containing innumerable Alpine lakes and some of the largest living glaciers within continental United States. It is the home of the largest herd of mountain sheep left in Wyoming. Its mountains include Fremont and Gannett Peaks—the two highest in the state. The canyons are extremely deep and precipitous.

The Stratified Primitive Area has been built up of eruptive rock from the Mt. Washburn volcanic area, in the Yellowstone Park, and Lava Mountain, at the head of Wind River. This eruptive material has been laid down in horizontal strata which are unstable and break down irregularly, often resulting in step-like precipitous cliffs and buttes, separated by many narrow valleys.

The abundance and tameness of wild life lends charm to the surroundings. This is the chief summer range of the Wind River elk herd of about 1,500 head. Deer are also plentiful. Mountain sheep and moose are often seen. The unit is also rich in the petrified remains of forests of earlier geologic times. Sections of petrified trees may be found in streams and standing petrified tree trunks may be seen elsewhere.

The designation of these lands as primitive areas means that they will be retained virtually in their natural state, and no motor roads, summer homes, resorts or other forms of settlement will be permitted within their boundaries. These areas are admirably adapted for the purpose for which they have been selected and will afford opportunities for present and future generations to visit and enjoy a wonderfully scenic region unchanged by modern civilization.

THE ANNUAL REVIEW OF BIOCHEMISTRY

THE first volume of the *Annual Review of Biochemistry*, published on May 3, is the introductory number of a new publication in the field of biochemistry. It is the purpose of the *Review* to present for the use of biochemists, physiologists, agricultural, organic and medical chemists, and scientists in related fields, annual and biennial surveys of the literature in biochemistry. Thirty to thirty-five subjects of major interest will be reviewed. The work is of international authorship, contributors having been selected from this country, Canada, Great Britain and continental Europe. The names follow: R. J. Anderson, M. L. Anson and A. E. Mirsky, W. R. Bloor, J. L. Bollman and F. C. Mann, L. R. Cerecedo, J. B. Collip and D. L. Thomson, Hans Fischer and F. W. Neumann, R. A. Gortner, L. J. Harris, M. Heidelberger, D. R. Hoagland, R. Hober, E. G. Holmes, N. N. Ivanov, P. Karrer and A. Helfenstein, H. D. Kay, P. A. Levene and A. L. Raymond, H. B. Lewis, J. M. Luck, Joseph Needham, J. Parnas, R. Robinson, W. C. Rose, L. Ruzicka, C. L. A. Schmidt, P. A. Shaffer and E. Ronzoni, C. P. Sherwin, A. T. Shohl, I. Smedley-MacLean, Arthur H. Smith, H. A. Spoehr, M. Stephenson, H. B. Vickery, E. Waldschmidt-Leitz, A. Windaus and R. Wurmser.

The *Review* is being published under the direction of an Advisory Committee consisting of C. L. Alsberg, D. R. Hoagland, J. Murray Luck (Chairman and editor) and C. L. A. Schmidt, and with the financial support of the Chemical Foundation.

The first volume covers the literature of 1930 and 1931 with the exception of several reviews which pertain strictly to material published in 1931. It is of 730 pages and contains approximately 3,850 bibliographic references. The volume is published by Stanford University Press.

THE SIGMA XI CHAPTER OF THE UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE

THE annual meeting of the Sigma Xi Chapter of the College of Medicine, University of Illinois, was held on May 12. Fifteen members and twenty-two associate members were elected.

Dr. F. R. Moulton, past president of the National Society, was present and addressed the meeting. Dr. L. B. Wilson, national president, also gave an address. The Northwestern Chapter was represented by Dr. L. B. Arey, professor of anatomy, and president of the chapter. Professor E. S. Bastin represented the University of Chicago Chapter.

The scientific program was:

"New Studies on the Thyroid Gland," Dr. G. Zechel.

"The Histogenesis of the Valvular Lesions in Endocarditis Lenta (Subacute Bacterial Endocarditis), Dr. R. H. Jaffe.

Each year the Sigma Xi presents a prize to the student doing the most important research during the year. This competition is confined to undergraduates. The prize this year was awarded to Edgar A. Thacker—subject: "For a Study of the Physiological Action of Irradiated Ergosterol."

The University of Illinois College of Medicine is the only independent chapter connected with a medical college. There is, however, a similar organization at the Mayo Institute. The University of Illinois and the University of Minnesota are the only universities each having two distinct chapters.

The officers elected for the coming year are:

Charles S. Williamson, *President.*
W. J. R. Camp, *Vice-president.*
Isadore Pilot, *Treasurer.*
William H. Welker, *Secretary.*

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

The second and final meeting of the Board of National Research Fellowships in the Biological Sciences for the award of 1932–33 appointments was held in Washington on April 28 and 29. In addition to the eleven reappointments and twelve new appointments voted at the February meeting, nineteen further reappointments and twenty-four first appointments were made at the current meeting, as follows:

Reappointments

For domestic study—Bachus, Myron P., agriculture; Bayroff, Abram G., psychology; Carpenter, C. Ray, psychology; Clarke, Alfred E., agriculture; Claus, Walter D., zoology; Craig, Lyman C., zoology; Dexter, Stephen T., agriculture; Garvey, Chester R., psychology; Hollaender, Alexander, botany; Lammerts, Walter E., botany; Leonard, Samuel L., zoology; McClintock, Barbara, botany; Nelson, Warren O., zoology; Saeger, Albert C., botany; Snell, George D., zoology; Stone, Raymond G., zoology; Zscheile, F. P., Jr., botany.

For study abroad—Graubard, Marc A., zoology; Valentine, J. Manson, zoology.

New Appointments

For domestic study—Bond, R. M., zoology; Boughton, D. C., agriculture; Burkholder, P. R., botany; Casida, L. E., agriculture; Drayton, F. L., botany; Fry, G. A., psychology; Glass, H. B., zoology; Horton, G. P., psychology; Jackson, Theodore A., psychology; Kaufmann, B. P., botany; Kerr, Thomas, botany; Miller, E. S., botany; Morsh, J. E., psychology; Phelps, Austin, zoology; Riley, H. P., botany; Schubert, H. J. P., psychology; Shaw, Luther, agriculture; Smith, William K., agriculture; Taylor, G. W., zoology; Tharp, W. H., agriculture; Wolfe, J. B., psychology.

For study abroad—Mandelbaum, May, anthropology; Smelser, G. K., zoology; Wald, George, zoology.

THE AMERICAN ACADEMY OF ARTS AND SCIENCES

At the annual meeting of the American Academy of Arts and Sciences held at Boston on May 11, the following new fellows were elected in the scientific classes:

Class I—Mathematical and Physical Sciences

Clarence Raymond Adams, Brown University.
Albert Arnold Bennett, Brown University.
Glennon Gilboy, Massachusetts Institute of Technology.
Albert Haertlein, Harvard University.
Einar Hille, Princeton University.
Ralph Restieaux Lawrence, Massachusetts Institute of Technology.
Kenneth Lamartine Mark, Simmons College.
Walter Cecil Schumb, Massachusetts Institute of Technology.
David Vernon Widder, Harvard University.

Class II—Natural and Physiological Sciences

Joseph Charles Aub, Harvard Medical School.
Franklin Greene Balch, Boston.
Elliott Carr Cutler, Harvard Medical School.
Frederick Kuhne Morris, Massachusetts Institute of Technology.
David Rapport, Tufts College.
Ralph Hartley Wetmore, Harvard University.

Foreign Honorary Members

Frederick Orpen Bower, Ripon, England.
Kingo Miyabe, Sapporo, Japan.
Albert Charles Seward, Cambridge, England.

The following officers were reelected:

President, Jeremiah D. M. Ford.
Vice-president (for Class I), Harry M. Goodwin.
Vice-president (for Class II), Walter B. Cannon.
Vice-president (for Class III), Edwin F. Gay.
Vice-president (for Class IV), Charles B. Gulick.
Corresponding Secretary, Tenney L. Davis.
Recording Secretary, Walter E. Clark.
Treasurer, Ingersoll Bowditch.
Librarian, Alfred C. Lane.
Editor, Herbert V. Neal.

PORTRAIT OF PROFESSOR HUBER

Dr. G. Carl Huber, professor of anatomy, director of the anatomical laboratories and dean of the Graduate School of the University of Michigan, was honored in special ceremonies by the students, friends and colleagues, on May 16, when a portrait in oil of himself was presented to the university.

Dr. Frederick G. Novy on behalf of the donors in presenting the portrait stated in part: "We are gathered here to honor one who has served his alma mater long, faithfully and efficiently. Conspicuous as a teacher and adviser, investigator and administrator, he has won recognition for himself and honor for the university. From the beginning of his career, as I have known from personal contact, Dr. Huber has been guided by the spirit of research, the uncompromising ideal of the investigator. The elaborate studies which he has pursued in his chosen field of histology and embryology have enriched our knowledge and have brought him well deserved recognition among his fellow workers."

Dr. Alexander Grant Ruthven, president, accepted the portrait on behalf of the university. The painting, an excellent likeness of Dr. Huber, is the work of Gari Melchers, the New York artist who was called to Ann Arbor almost twenty years ago to prepare the portrait of Dean V. C. Vaughan.

The event marked the forty-fifth anniversary of the graduation of Dr. Huber from the university and also the forty-fifth year of continuous service as a teacher in the Medical School. The gift was made possible through the contributions of students from each of the medical classes that have studied under Dr. Huber, colleagues and friends.

SCIENTIFIC NOTES AND NEWS

THE Kelvin Medal of the British Institute of Civil Engineers for 1932 was presented to the Marchese Guglielmo Marconi by Lord Rutherford on May 3.

THE University of Cambridge has arranged to confer the honorary degree of LL.D. on Sir William H. Bragg, director of the Royal Institution, London.

DR. E. D. MERRILL, director-in-chief of the New York Botanical Garden, was elected an honorary member of the German Botanical Society at its fiftieth anniversary meeting in Berlin on May 18. The two other American botanists who have received this honor are Dr. Asa Gray and Dr. Roland Thaxter.

ON the occasion of the annual Members' Day of the New York Zoological Society, a white oak tree was planted near the Elephant Walk in honor of Dr. William T. Hornaday, director emeritus of the Zoological Park. It was presented by Hermann W. Merkel, general superintendent of the Westchester Park Commission. Dr. W. Reid Blair, director of the park, accepted the gift. Prior to the garden party, the annual luncheon of the board was held in the administration building. Dr. Charles H. Townsend, director of the New York Aquarium, received a bronze statue of a Townsend fur seal in recognition of his thirty years of service at the aquarium. The bronze was executed by James L. Clark, sculptor-taxidermist of the American Museum of Natural History.

PROFESSOR L. M. DENNIS, head of the department of chemistry, Cornell University, will become professor emeritus at the close of the academic year in June. He became instructor at Cornell in 1887 and head of the department in 1903.

AFTER the retirement of President John Grier Hibben in June, Dr. Luther Pfahler Eisenhart, professor of mathematics and dean of the faculty at Princeton University, will be largely responsible for the internal administration of the university, in accordance with the by-laws which provide that whenever the president of the university is absent the dean of the faculty shall take his place. Edward Dickinson Duffield, president of the Prudential Life Insurance Company and a life trustee of the university, will be acting president.

DR. JAMES EWING has been appointed director of Memorial Hospital for the Treatment of Cancer and Allied Diseases by the Board of Managers, in full charge of all its departments and activities. The appointment will take effect on July 1.

AT the New Orleans meeting the House of Delegates of the American Medical Association elected Dr. Dean Lewis, professor of surgery at the Johns Hopkins University and surgeon-in-chief of the Johns Hopkins Hospital, to the office of president-elect. He succeeds Dr. Edward H. Cary, of Dallas, Texas.

DR. G. CANBY ROBINSON, director of the New York Hospital and Cornell Medical College Association, was elected president of the Association of American Physicians at its recent annual meeting. Dr. James H. Means, Jackson professor of clinical medicine in the Harvard Medical School, was reelected secretary. The next annual session will be held at Washington, D. C.

AT the annual meeting of the American Physiological Society on April 29, Dr. Arno B. Luckhardt, of the University of Chicago, was elected president, and Dr. Frank C. Mann, of the Mayo Foundation, was elected secretary. The next annual session will be held at Cincinnati, probably in April, 1933.

DR. WILLIAM DEB. MACNIDER, Kenan research professor of pharmacology at the University of North Carolina, was elected president of the American Pharmacological Society at the recent annual meeting in Philadelphia.

DR. J. M. HANSELL, formerly senior geologist with the Wisconsin Geological Survey, has accepted a position with the Arkansas Geological Survey as assistant to George C. Branner, state geologist.

DR. WILLIAM B. BRIERLEY has been appointed professor of agricultural botany at the University of Reading, England, in succession to Professor J. Percival who is retiring next September. Since 1918 Dr. Brierley has been head of the department of mycology in the Institute of Plant Pathology at the Rothamsted Experimental Station.

DR. W. D. URRY, at present fellow at the Johns Hopkins University, has been given a research fellowship at the Massachusetts Institute of Technology by an anonymous donor, to enable him to continue his investigations regarding the geological age of minerals through a study of their radioactive and rare gas contents. Dr. Urry will also collaborate with a group of investigators from the Massachusetts Institute of Technology, Harvard University and the U. S. Department of Agriculture in studies of the composition of the atmosphere at high altitudes with reference to chemical composition, occurrence of dust, spores, larva, bacteria and their significance.

THE Committee on Scientific Research of the American Medical Association has given to Dr. Bernhard Steinberg, director of laboratories and department for medical research of Toledo Hospital, Ohio, a grant for the continuation of the experimental work on protection of the peritoneum against infection. The committee had previously given him two other grants for the work on peritonitis.

AMONG Americans who will attend the meeting of the International Congress of Mathematicians to be held in Zurich, are Dr. David Eugene Smith, professor emeritus of mathematics at Teachers College, Columbia University, and Dr. W. A. Hurwitz, professor of mathematics at Cornell University.

DR. ALEŠ HRDLIČKA, of the U. S. National Museum, sailed on May 18 for Kodiak, Alaska, to continue his anthropological work in the Behring Sea region.

DR. WILTON M. KROGMAN, of Western Reserve University Medical School, will be this summer at the head of an anthropological expedition to study Seminole Indians in Oklahoma under the auspices of the Rockefeller Foundation.

THE Carnegie Institution, cooperating with Duke University and the University of Michigan, has sent an expedition to Yucatan to investigate biological problems. The members are A. S. Pearse, ecologist; F. G. Hall, physiologist; Edwin P. Creaser, carcinologist, and William C. Steere, botanist. The party sailed from New Orleans on May 31 for Progreso and will return about September 1. Work will be done at Chichen-Itza, Campeche and Merida.

DR. FREDERICK L. HOFFMAN, consulting statistician, of Wellesley Hills, Massachusetts, expects to sail from Montreal on June 3. He is going abroad chiefly in connection with his cancer research studies with particular reference to the dietary and nutritional aspects.

J. M. STAGG, leader of the British Polar Year Expedition which will spend next winter at Fort Rae in the North West Territory, left Southampton on May 14, in the S. S. *Alaunia.* He was accompanied by A. Stephenson. The remainder of the party, Messrs. W. Morgans, P. A. Sheppard, W. A. Grinsted and J. L. Kennedy, sailed in the *Aurania* a week later.

AT the request of Professor W. L. Bragg, his coming to Cornell University as non-resident lecturer on the George Fisher Baker Foundation has been postponed from next fall until a later date.

PROFESSOR PHILIP A. SHAFFER, of the biochemistry department of Washington University, St. Louis, has been invited to deliver the Herzstein medical lectures at the University of California for 1932.

DR. W. F. G. SWANN, of the Bartol Research Foundation; Dr. Saul Dushman, of the General Electric Company; Professor Debye, of the University of Leipzig, and Professor Charles A. Kraus, of Brown University, are the special lecturers this summer in the department of physics of the University of Illinois.

THE Stephen Walter Ranson lecture at Northwestern University Medical School, given annually under the auspices of the Phi Beta Pi Fraternity, was delivered on May 6 by Dr. Edgar Allen, professor of anatomy and dean of the School of Medicine at the University of Missouri. The title of the lecture was "The Internal Secretions of the Ovaries."

DR. LINUS PAULING, professor of physical chemistry at the California Institute of Technology, gave a John Howard Appleton Lecture at Brown University on May 2. His subject was "The Resonance of Molecules among Several Electronic Structures."

THE Linacre Lecture of the University of Cambridge was given by Dr. J. J. R. Macleod, regius professor of physiology at the University of Aberdeen, on May 6.

THE Halley Lecture of the University of Oxford for 1932 was delivered at the University Museum on May 19, by Professor E. A. Milne, Rouse Ball professor of mathematics and fellow of Wadham College. His subject was "The White Dwarf Stars."

PROFESSOR BASTAI, appointed to a chair of pathology at the University of Florence, recently delivered the inaugural lecture of his course, taking as his subject "Anemia Due to Lack of Hormones."

ON April 26 the District of Columbia Chapter of the Society of Sigma Xi held its annual meeting and dinner. Three newly elected members were presented to the chapter. These were Dr. Charles G. Abbot, secretary of the Smithsonian Institution; Dr. Ray S. Bassler, curator of geology in the U. S. National Museum, and Dr. William A. White, superintendent of the St. Elizabeths Hospital. Each responded with an account of research activities in which he was particularly interested. Dr. Abbot discussed some of the recent advances in the methods of measuring distances and magnitudes of the spiral nebulae. Dr. White presented an account of the developments in the study of the mind. Dr. Bassler described the geological record which he has developed at the National Museum.

DURING May and the first week in June a course of four lectures under the auspices of the California Academy of Sciences on the general subject of "The Beauties of Nature" are being given in the auditorium of the Pacific Gas and Electric Company, San Francisco. The titles and lecturers are: "Our National Park System; What the Federal Government is doing to conserve and make known the Beauties of Nature," by Col. John R. White, superintendent of the Sequoia and General Grant National Parks; "Western American Scenery as exemplified in our National Parks," by Francis P. Farquhar, vice-president of the Sierra Club; "Off the Track in Central America; the History, the Peoples and the Natural Beauties of those Little-known Countries," by John Malcom Nicol, mining engineer and traveller; "Spiritual Values in Appreciation of Nature," by Dr. John C. Merriam, president of the Carnegie Institution of Washington. Each of the first three lectures will be illustrated by stereopticon slides and moving pictures. These are the first of a course to be given annually on "The Beauties of Nature" by the academy, and for which a friend of the academy has provided a permanent endowment of $10,000.

THE *British Medical Journal* reports that it has been decided to form a museum in connection with the Centenary Meeting of the British Medical Association, and the arrangements have been entrusted to the special Museum Committee, constituted as follows: Sir Arthur Keith (chairman); Dr. D. Evan Bedford, Dr. A. B. Bratton, Dr. R. G. Canti, Dr. E. Ffolliott Creed, Dr. Sydney H. Daukes, Dr. J. G. Greenfield, Dr. H. K. Graham-Hodgson, Dr. Donald Hunter, Mr. P. H. Mitchiner, Dr. John O. Oliver, Mr. Thomas G. Stevens, Mr. C. P. G. Wakeley. The honorary secretaries are Mr. Mitchiner and Dr. Oliver. It has been decided to group the museum into the following sections, each under the arrangement of the member named, to whom all communications as to exhibits in the appropriate section should be addressed. Medicine (with diseases of children and orthopedics), Dr. Hunter; Surgery, Mr. Wakeley and Mr. Mitchiner; Obstetrics and Gynecology, Mr. Stevens; Neurology (with mental disorder), Dr. Greenfield; Pathology and Bacteriology, Dr. Bratton; Radiology, Dr. Graham-Hodgson; Tropical Medicine, Dr. Daukes, and Otolaryngology.

THE New York Hospital-Cornell University Medical Center covering three entire blocks along the East River between Sixty-eighth and Seventieth Streets, which has been under construction since the autumn of 1929, will open on September 1. The present New York Hospital, the Lying-in Hospital and the Manhattan Maternity and Dispensary will close their present plants about August 1 to move into the new center. Cornell University Medical College will begin to move at the end of the present school term in June and will open the fall term in the new buildings on September 29. More than half of the 1,000 beds in the hospital will be ready for occupancy at the outset.

CULTURAL institutions in Peiping prepared to welcome in May the Sino-Swedish expedition to central Asia, which returned after five years of exploration and observation in the Kansu, Sinkiang and Mongolia. The expedition left Peiping in 1927 with Dr. Sven Hedin and Dr. Hsu Ping-chang as leaders, and has since been carrying out excavations on a large scale in the Lama territory, in little known parts of the Gobi Desert and in Chinese Turkestan.

THE University of California has accepted the gift of W. H. Kellogg's Arabian horse ranch near Pomona, and a $600,000 endowment, and has agreed to carry on for two-score years the work of the donor. The undertaking is expected to finance research work in animal genetics and at the same time, through surplus of increase, help to stock ranches and stables with a finer breed of saddle horses than the West ever has known.

A GIFT of $32,300 has been made from the Commonwealth Fund, to Columbia University for research into the causes of dental decay.

COLBY COLLEGE has received a gift of more than 200 volumes in the field of geology from George Otis Smith, of the class of 1893, formerly director of the U. S. Geological Survey. They will be known as "The George Otis Smith Collection in Geology" and form a nucleus for a research library in this subject.

A 6,000-acre forest laboratory for forestry research and experimental work has been established by the Forest Service near Westwood, California, in the Lassen National Forest. This experimental forest is the first of the kind to be established in California. It will be under the supervision of the California Forest Experiment Station.

Museum News reports that the Rothschild collection of 280,000–300,000 bird skins from the Tring Museum has been purchased for the American Museum of Natural History, New York The collection covers the field of European and Asiatic bird life. It is expected to fill out the American Museum collection, which already contains about 500,000 specimens. The Rothschild collection includes a large number of type specimens.

THE addition of Wonder Lake and other areas to Mount McKinley National Park has been announced. Mount McKinley Park is the farthest north of the national parks of the United States, and contains the highest mountain on the North American continent. It rises higher from its base than any other mountain in the world, not excluding the Himalayas. The total height of the great peak is 20,300 feet, and on its north and west sides it rises abruptly from a tundra-covered plateau only 2,500 to 3,000 feet above sea-level. Mount McKinley rises 17,000 feet above timberline, and for two thirds of the way down from its summit it is enveloped in snow throughout the year. Closely rivaling scenic Mount McKinley as a spectacle are the great herds of caribou and Dall sheep that roam the park area. Indeed, it was mainly to afford these animals protection that the national park was established in 1917. The inclusion in the park of the Wonder Lake area, lying to the northwest, is important from three main standpoints: From this area may be obtained the most advantageous view of the great mountain obtainable anywhere in the park; the lake shore affords the best location for the establishment of a tourist center within the park, with hotel and other facilities, and its lowlands provide excellent pasture for the park's wild animals, as well as affording them protection from hunters during the winter season when these animals migrate to the lowlands. Good fishing also is available at Wonder Lake, and boat trips can be developed for those not wishing to take the longer, more laborious pack trips. On the east the park boundaries are extended so as to make the west bank of the Nenana River, for all practical purposes, a natural boundary line for the park. The total area of the park with the recent additions is 1,939,493 acres.

DISCUSSION

THE POSSIBLE CHEMOTACTIC EFFECT OF THE SALIVARY SECRETIONS OF CERTAIN INSECTS UPON MICROFILARIAE

IN his valuable report upon *Onchocerca* investigations in Guatemala,[1] Strong states that three species of a Eusimulium fly are concerned in the transmission of *Onchocerca caecutiens* and that if one of these flies "is allowed to bite on the face of an infected individual, there are found on examination of the blood in the abdomen many more microfilariae than are encountered in the direct examination of the skin, but, in a case where a previous examination of a section of the skin of the face has shown no microfilariae, if a second section is made through or very near the spot where a fly has just bitten, very large numbers of microfilariae (over one hundred) may be found in it. Very clearly the fly usually produces in some way during feeding a concentration of the microfilariae about the point of the bite, many of which it imbibes." Strong then calls attention to the usefulness of this phenomenon in diagnoses where the microfilariae are present only in very small numbers.

A similar phenomenon was observed by Ashburn and myself during our investigations of the development of the microfilariae of *Filaria philippinensis* in the Philippines during 1907 and reported in the *Philippine Journal of Science*, Volume 11, No. 1, of that year. This microfilaria, which we regarded to be a new species, but which is now generally considered to be identical with the microfilaria of *Wuchereria bancrofti*, possesses no periodicity and usually occurs in the blood in very small numbers. In investigating the development of this microfilaria in the mosquito, *Culex quinquefasciatus*, we noted that blood ingested by the mosquito contained many more microfilariae than we could find in approximately the same amount of blood obtained from the patient. Regarding this we stated:

> One of the earliest observations to be made in studying infected mosquitoes is one relating to the number of filariae ingested. In some manner, concerning which it is possible to construct interesting hypotheses, the mosquito manages to get from the body of the patient 40 to 50 or more times as many filariae as it is possible

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[1] *New England Journal of Medicine*, Vol. 204, p. 916, 1931.

for us to obtain in a similar amount of blood from a needle prick. Thus, in good thick smears under 22 millimeter (⅞-inch) cover glasses, we will usually find but one or two, and oftentimes no filariae. In the blood from the stomach of a mosquito which has recently bitten, the amount of blood usually appears to be less than in these thick cover-slip preparations, but it is nearly always possible to find from 40 to 80 filariae, and it has occurred to us that this fact might have a practical value in examining cases of suspected filariasis in which the parasites are so few in number as readily to be missed. It might be of use in revealing embryos in the blood of cases of elephantiasis, where the filariae, though believed to be present, are seldom found. We have not had an opportunity to put our suggestion into practice except on our last four cases of known filariasis, in all of which the result has been as stated.

So far as is known, this observation regarding the phenomenon described has not been confirmed by other workers, but it would appear to merit further study, both from the standpoint of scientific interest and practical diagnostic importance. In view of the fact that the same phenomenon occurs in *Onchocerca* infections, it is probable that it also occurs in other conditions in which parasites are transmitted by blood-sucking insects.

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AINU PITS IN THE KURILE ISLANDS

In the summer of 1931 I had an opportunity to visit the largest of the Kurile Islands, Etorofu. Arriving there on August 3 at a small village called Rubetsu, our party proceeded to cross the island on foot, collecting on the way. That evening at dusk we came to the Pacific Ocean and chanced upon some Ainu pits. At that time we only found a few broken pieces of pottery.

The next day, while hunting for new specimens of spiders, a slight exposure of shell near one of the Ainu pits was found. Upon investigation at a near-by village of Toshimoe, we found that these mounds had never been opened.

After digging in these mounds for two days we found a large quantity of pottery—mostly broken pieces and one complete vase with a good bear design. Several bone tools were also found, one a U-shaped instrument made from whalebone, the use of which has not been determined. As far as known this is a new find and not recorded from any other mound in Japan. The shells were found under twelve to eighteen inches of soil. The heap was to the north of the pits and had probably been thrown there from the doorways of the huts.

The age of the finds is an extremely difficult matter to determine. All evidence points to a stone age period, but as the Ainu, in isolated places, continued to use stone after contact with the Japanese their age can not be determined. A safe estimate would place the date at no more than five hundred years ago. The pottery designs are typical of the Ainu art, though less ornate than those found at other places in Hokkaido and the Kuriles. On the eastern coast of Etorofu at Wannippu there are many Ainu pits, and in a trip of less than five miles over forty pits were counted.

The larger part of this material is now in the Hokkaido Imperial University at Sapporo, where other valuable finds have been placed. A detailed study with drawings of it will be made this coming year.

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THE JESUIT FOURTH VOW

IN view of the statement of Dr. José F. Nonidez in SCIENCE for May 6, pp. 488–489, it will be of interest to the readers of this journal to know the precise wording of the fourth vow taken by some of the members of the Society of Jesus (the Jesuits). The Latin text is: "Insuper, promitto specialem obedientiam Summo Pontifici circa missiones, prout in iisdem litteris Apostolicis et Constitutionibus continetur." (Constitutiones Societatis Jesu, Pars V, Caput III, 3; 1869 Ed., I, 78). Translated this is: "Besides, I promise special obedience to the Supreme Pontiff in regard to the missions, according to the content of the same Apostolic Letters and Constitutions (*i.e.*, Papal Letters of Approbation and Constitutions of the Society of Jesus)." It is obvious that this vow is implicitly contained in the third of the immediately preceding three religious vows which Dr. Nonidez rightly says are unobjectionable, and that it only stresses a point of religious obedience, the substance of which is common to all religious orders that engage in missionary activities. It is of purely spiritual import, and does nothing more than express a readiness to go anywhere in the world on missionary duty if the Pope should so command.

JAMES B. MACELWANE, S.J.

INDEXES OF BIOLOGICAL ABSTRACTS

THE Board of Trustees of *Biological Abstracts* is now in position to assure readers of *Biological Abstracts* that the editorial and publication difficulties that have stood in the way of prompter issuance of the indexes have been overcome, through a grant for the purpose by the Rockefeller Foundation. The index of Volume 2 will be mailed in the fall, and the others will follow as rapidly as the necessary editorial work can be accomplished. With the indexes of the earlier volumes completed, each subsequent index should be available reasonably promptly after completion of the corresponding volume. Specific announcements will be made from time to time in current numbers of *Biological Abstracts*.

C. E. McClung,
President, Board of Trustees,
Biological Abstracts

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF COLOR FILTERS IN COLORIMETRIC ANALYSIS

It is a common difficulty in colorimetric work to encounter conditions in which a color match between a solution of an unknown and one of a pure substance is very imperfect. Although in recent years more and more use has been made of limiting the portion of the visible spectrum used for this work, it is probable that not enough workers realize the advantages to be gained by such limitations or the ease of their application. Among recent methods utilizing selected portions of the spectrum can be mentioned those described in the articles of Kennedy, Flesche and McClendon, Gregory and Pascoe, Folin and Malmros, Cavett and Armstrong.

Kennedy[1] made a careful spectrophotometric study of blood solutions, and on the basis of the study advocated the use of a light filter for the determination of hemoglobin as carbonyl hemoglobin, using a "neutral grey" filter as a standard. Flesche and McClendon[2] used the same light filter, but employed the Newcomer glass as a standard.

Gregory and Pascoe[3] made a careful spectrophotometric study of the color produced by the reaction of bile salts with furfural in sulfuric acid of a definite concentration, and determined the most marked absorption band of the resulting product. They then obtained light of the same wave-length as that absorbed in this band by means of a neon lamp and appropriate color filters.

The above methods employing light approximating monochromatic represent undoubtedly the best method for obtaining a color match between two colored solutions, since no other substance with absorption in other regions can have any effect on the color match obtainable. However, a spectrophotometric analysis of the colors produced by a given reaction requires special equipment not available to all research workers, and certainly not available to many clinical laboratories. As will be shown, excellent results can be frequently obtained without the use of a laborious technique.

Bausch and Lomb was unable to produce a glass that would give the same spectrum as does acid hematin. A divergence of the curves given by the glass and by the solution was encountered in the longer wave-lengths. A good match was obtained by blocking out the longer lengths with a blue glass filter. Armstrong[4] found that use of this same blue glass allowed a good match of colors in his method for the determination of fluorine. In these cases, while careful studies were made of the absorption spectra involved, it was not found necessary to use monochromatic light, the mere shutting out of one end of the spectrum being sufficient restriction.

Folin and Malmros[5] were troubled by contamination of the blue color of colloidal ferric ferrocyanide by varying amounts of potassium ferricyanide. The latter substance absorbs rays at the short end of the spectrum, while the Prussian blue absorbs the longer rays. The authors mentioned found by trial that they obtained a close match of the two fields when the amount of light of short wave-length was cut out or decreased by transmission through yellow paper. In this laboratory, when their method is used it is found more convenient to block out violet and blue rays by passage of the light through a jar of potassium ferricyanide solution or of picric acid solution.

Recently workers in this laboratory have adopted the following simple procedure when difficulty is encountered in securing a color match between an unknown mixture, as blood or urine, and a standard pure solution. Results have been excellent. Cavett[6] employed this method, finding that a color filter gave a much better match between standard and unknown in Hanke and Koessler's analysis for histidine. Other workers are now using filters in procedures to be described in future papers.

Carry out the color reaction with a fairly strong pure solution on the substance for which analysis is to be made. Pour the resulting solution in a flat-sided vessel, and examine its absorption spectrum by means of a simple hand spectroscope, using the same light source later to be used for the colorimeter. Dilute the solution, and inspect again. Note the region of the spectrum in which the maximum change of absorption occurs. Next examine, with the same light source, several light filters or solutions of various chemicals, until one is found which transmits light in the region of absorption by the above solution, but which absorbs as completely as possible all other light. Superimposition of the filter and the strong standard solution should shut out practically all visible rays. If the color filter finally adopted is of glass or other solid material, it can be placed over the eyepiece of the colorimeter, cut to fit inside the ocular tube of the colorimeter, or placed over the source of light. If the color filter is a solution, it can be placed in a flat-sided glass jar, as a museum jar, which is then placed in front of the colorimeter, or can be placed in accessory cups, of equal depth, one of which is placed under each colorimeter cup. A colored light source, as a neon lamp, may be used.

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[1] R. P. Kennedy, *Am. J. Physiol.*, 78: 56, 1926; *ibid.*, 79: 346, 1927.

[2] R. A. Flesche and J. F. McClendon, *Soc. Exp. Biol. Med.* 25: 791, 1929.

[3] R. L. Gregory and T. A. Pascoe, *J. Biol. Chem.*, 83: 35, 1929.

[4] W. D. Armstrong, *Soc. Exp. Biol. Med.*, 29: 414, 1932.

[5] O. Folin and H. Malmros, *J. Biol. Chem.*, 83: 115, 1929.

[6] J. W. Cavett, *J. Biol. Chem.*, 95: 335, 1932.

Where it is desired to block out the long end of the spectrum, a Bausch and Lomb blue hemoglobin filter can be used. An aqueous solution of picric acid blocks out the short end. These two superimposed allow practically no light to pass, except two faint bands in the green and in the yellow, respectively. A potassium chromate solution acts similarly to a picric acid solution. A solution of nickel sulphate blocks out both ends of the spectrum, and transmits the middle portion. If desired, a set of glass or gelatin filters may be purchased from an optical supply house, and will be found quite convenient. In many instances, however, they will be found not at all superior to the above-mentioned improvised filters, and ones similar to them, available in any laboratory.

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SPECIAL ARTICLES

PROBABILITY OF THE PRESENCE OF A SEX ANTAGONISTIC SUBSTANCE IN URINE

IT has been frequently observed in this laboratory that certain extracts of normal, as well as of pathological urines, when injected into immature animals, inhibit the development of sexual organs. The results first obtained were not very uniform, as the treatment was never extended beyond a week. By extending the injections longer we obtained in a series of experiments typical sex organ inhibition. One of such experiments of 32 days' duration will be described here in detail.

Six male and six female rats of about the same initial weight were placed on an artificial food mixture consisting of casein, starch and salts with the daily addition of 0.5 gm dried yeast, 2 drops of cod-liver oil, 1 gm of dried milk and 400 mg of lard. The animals were divided into three groups, controls and two groups receiving daily subcutaneous injections of two different urine extracts, representing 250 cc of urine daily. The extracts were prepared in the following way.

Mixed male and female urines[1] (non-acidified) were extracted for 48 hours in a continuous extractor with ether. The ethereal extracts were evaporated and the residue extracted with as many cc of water, that one cc of extract represented one liter of the original urine used. The second extract was prepared from the water-insoluble material, by dissolving the residue in a corresponding amount of peanut oil. The two extracts, prepared fresh every few days, showed the following general characteristics. The aqueous extracts were of a brown-yellow color and deposited on standing a brown oxidation pigment. They contained probably small amounts of the cortical suprarenal hormone and traces of female hormones. The oil-soluble extracts, on the other hand, contained no detectable amounts of andronin (male sex hormone), but relatively large amounts of theelin-like substances, which were, however, mostly insoluble in alkali. The animals were weighed every 4 days and the food intake determined every second day. The food intake was fair in all experimental groups and the growth of females was comparable in all the groups. These facts would practically eliminate the probability of toxic effects of the injections. After 32 injections the animals were sacrificed and the weight of testicles and seminal vesicles in the males, and of ovaries and uteri in females was determined in absolute figures, as well as per gm of body weight. The table below summarizes the experiment, the figures representing the average of two animals.

As contrasted with short experiments which show sometimes stimulation and sometimes inhibition of development of sex organs in males and a constant stimulation in females, the described typical experiment of longer duration leaves the males in the infantile stage, while a marked retardation is noticed in females. The difference in the degree of influence in the 2 sexes is tentatively explained by the compen-

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[1] Our thanks are due to the authorities and the head nurse of Hôpital Stell, Fondation Edward Tuck, in Rueil-Malmaison for supplying us with urines of patients for our investigations.

MALES

Rats number	Weight		Per cent. incr.	Food int.	Per gm body wt.	Gonads in mg.	Per gm body wt.	Sem. ves. in mg.	Per gm. body wt.	
	Initial	Final								
406 407	49.5	153.5	210	584	2.8	*4622.3*	*15.0*	*534.9*	*1.7*	Controls
410 411	53.5	172.5	222	626	2.6	*4789.1*	*13.8*	*822.9*	*2.4*	Aq. extr.
414 415	49.5	109.5	121	467	3.9	*976.5*	*4.4*	*44.3*	*0.2*	Oil-sol. extr.

FEMALES

Rats number	Weight		Per cent. incr.	Food int.	Per gm body wt.	Ovaries in mg.	Per gm. body wt.	Uteri in mg.	Per gm body wt.	
	Initial	Final								
408 409	50.0	125	150	575	3.8	*184.7*	*0.73*	*635.3*	*2.5*	Controls
412 413	48.5	119	145	531	3.8	*232.3*	*0.97*	*623.0*	*2.6*	Aq. extr.
416 417	47.0	115.5	145	484	3.5	*125.1*	*0.54*	*307.9*	*1.3*	Oil-sol. extr.

satory effect of theelin-like substances present in relatively large amounts in the oil-soluble extracts.

The sex-inhibiting substance was found roughly in the same fraction which contains the male hormone and is present in normal urine. Control experiments of long duration injecting male and female hormones to their respective sexes, as well as treating male animals with female hormone and *vice versa* did not show any appreciable inhibitive effect on sex organs. Some of the inhibitive action of sex hormones, described in the literature, might be due to the presence in them of the substance described in this paper.

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BERRIES RICH IN CALCIUM

HACKBERRIES[1] (*Celtis occidentalis* L.—Urticaceae) have long been used as food by various tribes of North American Indians. The Dakotas[2] pounded the fruit (including pits) and used them as a flavor for meat. The Pawnees pounded the fruit and mixed them with fat and parched corn. The Meskwaki Indians[3] ground the fruit and made them into mush. Hackberries have a sweet pleasant taste with a flavor somewhat resembling that of figs.

The ripe fruit which was used in our investigation was collected during 1930 and 1931 in Nebraska and Kansas. Analysis of the fruit (pulp and pits were ground together) gave the following results (all figures refer to moisture-free fruit); reducing sugar (invert sugar) ranged from 32 to 36 per cent.; non-reducing sugars were absent; pentosans and hemicelluloses, 2–4 per cent.; crude fat (ether extract), 2.8 per cent.; crude protein, (N x 6.25), 11.6 per cent. While it is the usual practice to report separately the analyses of the edible portion of the fruit and the pit, in this article the analysis of the entire fruit is reported, first, because the Indians used the entire fruit, and secondly, because on account of the large pits and small pulpy part this is the only way to use the fruit economically.

The most interesting feature of this fruit is its mineral content. Analysis of several samples gave an average value of 29 per cent. ash, almost half of which (48 per cent.) was CaO, or 13.9 per cent. CaO in the moisture-free fruit. Evidence adduced below indicates strongly that the calcium is present in the fruit as calcium carbonate. In that case, 13.9 per cent. of CaO would correspond to 24.9 per cent.

[1] Although popularly known as berries, hackberries are botanically drupes.

[2] Gilmore, *33rd Ann. Rep.* Bureau Amer. Ethnol., p. 76, 1919.

[3] Smith, *Bull. Publ. Museum*, Milwaukee, p. 265, 1928.

$CaCO_3$, *i.e.*, calcium carbonate constitutes about one-quarter of the weight of the dry fruit. There were also present 1.2 per cent. of oxides of iron and aluminum, and 2.4 per cent. silica. The moisture content of the fruit as received ranged from 15 to 19 per cent.

Payen,[4] in 1854, analyzed the pits of the hackberry and proved that the calcium is present as carbonate by placing the ground, dried pits in dilute hydrochloric acid and weighing the carbon dioxide given off. The results of his analysis are as follows:

Organic matter	28.7 per cent.
Calcium carbonate	64.2 per cent.
Calcium phosphate	trace
Silica	7.0 per cent.

While it is apparent that most of the calcium in the fruit is present in the pit as carbonate, the possibility of the presence of other calcium salts must not be overlooked. In order to investigate this possibility 4.1 kilos of ground hackberries were extracted twice with boiling water. The dried presscake (1.7 kilos) contained 28.7 per cent. CaO and 54.7 per cent. ash. Direct determination showed that 23.6 per cent. of CO_2 was given off on addition of mineral acid to the ground fruit, thus confirming Payen's results and showing that the ash of the extracted material is mostly calcium carbonate. There were also 3.9 per cent silica, and 0.3 per cent MgO in the ash.

The water solution was extracted with ether and on evaporating the ether 16.5 gms of a yellow fatty oil, probably kernel oil, remained. The solution was then precipitated with alcohol. The resulting gummy precipitate weighed 45 gms and contained 10.1 per cent CaO (total ash 23.2 per cent.).

The aqueous-alcoholic solution was precipitated with lead subacetate, and the recovered acids were converted into ethyl esters (62.8 gms) and fractionated. The different fractions were identified by means of the hydrazides. Fraction 1 (0.7 gm) yielded oxalic hydrazide (m.p. 235°). The hydrazide of fraction 2 (1.6 gm) was identified as that of malic acid (m.p. 179°). Fractions 4–8 (23 gms) yielded citric trihydrazide (m.p. 106°). Fraction 9 produced an oily hydrazide. The acid of this fraction is an unsaturated acid which, on oxidation with cold 5 per cent. $KMnO_4$, yields succinic acid and an oily acid.

The conclusion therefore must be drawn that, although most of the calcium in hackberries is in the form of carbonate, there are also calcium salts of malic, citric and oxalic acids, and of some gummy acids, and an unsaturated acid of unknown constitution.

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THE NATIONAL ACADEMY OF SCIENCES. II

A recessive zygotic lethal resulting in 2: 1 ratios for normal vs. male-sterile and colored vs. colorless pericarp in F_2 of certain maize hybrids: R. A. Emerson. Maize hybrids between types with red and others with colorless ears normally have colored ears in the first generation, F_1, and exhibit in the second generation, F_2, the typical mendelian ratio of three colored to one colorless, with one third of the colored individuals breeding true in the next generation, F_3. A Peruvian maize with red mosaic ears, when crossed with local inbred strains having colorless ears, gave a 2: 1 ratio in F_2 and later generations involving over 1,100 plants. Moreover, the ratio of true breeding to segregating individuals among the colored ears was 1: 87, instead of 1: 2 as expected. Evidently the 2: 1 relation in F_2 is due to the almost complete elimination of the true breeding colored individuals. One of the inbred colorless strains used in crossing with the Peruvian maize was male-sterile, *i.e.*, it produced no good pollen. F_1 was normal, but in F_2 and later generations the normals were to the male-steriles as 2: 1, just as with ear color. Of the normals, only one in 37 was colorless and of the male-steriles, only one in 46 was colored. Obviously, this male-sterility is closely linked with ear color, so that whatever distorts the normal ratio of colored to colorless affects similarly the ratio of normal to male-sterile. If there be assumed a genetic factor, closely linked with the factor for colored ears, which prevents the development of the kernels which receive it from both the egg and pollen, the results obtained are readily accounted for. This hypothesis is rendered the more plausible by the fact that self-pollinated colored ears are not well filled with kernels.

The chromosomes of haploid maize, with special reference to the double nature of the univalent chromosomes in the early meiotic prophase: L. F. Randolph (introduced by R. A. Emerson). Certain characteristics of the chromosomes in the root-tip cells and in the microsporocytes of haploid individuals are described and illustrated. The presence of 10 chromosomes in each cell instead of the 20 present in normal diploids facilitated the study of individual differences between the members of the group in the somatic cells, and their existence as univalents rather than as bivalents in the meiotic prophase simplified the interpretation of the double condition of the chromosomes in this stage. At the time of the differentiation of the leptotene threads in the very early prophase the chromosomes were clearly double. The evidence for an interpretation of this doubleness as a longitudinal division of the univalent chromosome is presented. The significance of this observation is discussed in relation to its direct bearing on certain current theories of synapsis and crossing-over, which are based on the assumption that synapsis precedes the longitudinal division of the chromosomes. Non-correspondence of chromomeres in corresponding regions of sister chromatids was observed frequently throughout the early prophase stages. This suggests that in maize these structures have little or no morphological significance.

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[4] *Compt. Rend.*, 38, 241, 1854. Payen's *Celtis cordata* is synonymous with *C. occidentalis.*

Effects of monochromatic radiation in the visible and ultra-violet on the virus of typical tobacco mosaic: B. M. DUGGAR and ALEXANDER HOLLAENDER. The virus of typical tobacco mosaic, approximately purified, was exposed in solution of v/100 to monochromatic light at approximately 0° C. The virus dilution was made up, after pasteurization, in physiological salt solution in which was diffused *Bacillus prodigiosus* for purposes of comparison. The bacteria were at a concentration approximately 300,000 cells per cc. Exposure was made in a quartz cell provided with a quartz stirrer. The energy thrown in was measured by the usual thermopile-galvanometer procedure. Likewise, the energy absorbed by the solution was measured except in a few cases. Exposures for various intervals were made at suitable lines in the mercury spectrum from 6150 Å as the longest wave-length to 2537 Å as the shortest. Twelve spectral lines were employed, and with another monochromator and a spark source of radiation 2144 and 2315 Å were used. From the exposed solutions inoculation of tobacco plants were made at suitable dilutions. At the same time dilution cultures were made for bacterial counts, thus furnishing quantitative biological criteria. Tables and curves have been prepared, showing the lethal effects for both virus and bacteria. The results indicate that far greater intensities are required to inactivate the virus than to kill the cells of bacteria under precisely the same conditions. In general, within the range of time periods which are practicable, the inactivation of virus is limited to wave-lengths shorter than 3350 Å. A direct method of leaf radiation has been devised for work at different temperatures.

On the stability of physiological characters of bacteria: E. B. FRED. Variations which are more or less permanent changes in cultures are conceivably of two types—those concerned in possible life-cycles or dissociative changes in the bacteria and those of a deteriorative nature, resulting from prolonged exposure to the so-called "artificial" conditions of the laboratory culture. It is the purpose of the present paper to consider the latter type, citing cases of observations on certain biochemical characters of cultures freshly isolated and of the same cultures after some years of existence in the laboratory. Any tendency toward uniformity of cultures may be forgotten in the flood of publications which have focused attention on the problem of bacterial variation. Striking examples of such stability, covering the activities of a wide variety of bacteria, spore-forming and non-spore-forming, motile and non-motile, aerobic and anaerobic, were cited. No attempt was made to deal with bacterial dissociation or life cycles, but rather to present certain observed facts which relate to the stability of different groups of bacteria when kept for years under suitable artificial conditions. To the author it appears that the claims of gradual deterioration are not always supported by facts. The results of this study, therefore, support the fundamental concept of the stability of pure cultures of bacteria under suitable artificial conditions.

Henry as a physicist: W. F. MAGIE.

Henry as an electrical pioneer: BANCROFT GHERARDI.

Henry as an administrator: CHARLES GREELEY ABBOT.

Cosmic-ray energies and their bearing on the photon and neutron hypotheses: ROBERT A. MILLIKAN and CARL D. ANDERSON.

Distances and luminosities of four thousand of the brighter stars: WALTER S. ADAMS. The spectroscopic method of determining the distances of stars is based upon the fact that among stars of the same spectral type, that is, the same surface temperature, many of the spectral lines show differences in intensity which are correlated with the luminosity of the stars. Highly luminous stars with temperatures equal to or lower than that of the sun are of great size and have low densities, a condition which favors ionization in their atmospheres. Hence the lines due to the ionized atom are prominent in giant stars whereas the lines of the neutral atom, especially for elements of low ionization potential, are marked in the less luminous or dwarf stars. Stars of known luminosity are used to establish quantitative correlation curves between the intensities of selected spectral lines and the intrinsic brightness. The method, which was discovered at the Mount Wilson Observatory, has been applied to about 4,000 stars with temperatures ranging from over 10,000° C. to 3,000° C. The chief results of the study are: first, the striking evidence of the separation of stars with temperatures less than that of the sun into distinct classes of giants and dwarfs with no stars of intermediate luminosity; second, the merging of these classes among stars of the higher temperatures; and third, the remarkable tendency of both giant and dwarf stars of lower temperatures, but especially the giants, to fall within definite narrow limits of luminosity. An immense majority of such stars have almost exactly the same candle-power.

Nebulous objects in Messier 31 provisionally identified as globular clusters: EDWIN HUBBLE. One hundred and forty objects have been found in or close to the borders of Messier 31, the Andromeda nebula which, from their numbers, their distribution and the radial velocity of a typical example, are presumably to be associated with the spiral. From their forms, structure, colors, luminosities and dimensions, they are provisionally identified as globular clusters. Absolute photographic magnitudes range from -4 to -7 with maxima at -5.0 and -6.2. Diameters range from 4 to 16 parsecs. Galactic globular clusters, according to Shapley's data, are systematically brighter than the objects in M 31 by amounts varying from 0.75 to 1.95 mag., depending on the interpretation of the data. Known clusters in the Magellanic Clouds are comparable with the brighter objects in M 31. Objects apparently similar to those in M 31 are found in NGC 6822, M 33, M 81 and M 101.

The determination of the orbit of an object moving under the attraction of the sun and of the combined mass of earth and moon: A. O. LEUSCHNER and E. C. BOWER. As a measure of preparedness in case of the discovery of an object so close to the earth that the usual methods of orbit determinations do not apply, a solution is proposed, based on the equations of motion for three bodies, which in the first approximation determines whether the object is a planet or a satellite to the earth. A satellite would be revealed graphically through the intersection of a straight line with a bump in a curve, due to parallaxic terms arising from the difference of direction of the object as seen from the observer and the center of the mass of the earth-moon system. The process was illustrated by application to the recently discovered fast-moving Delporte object. The earlier observations of this object indicated the possibilities of its nature. It could be either a planet moving in a cometary orbit similar to that of Eros and passing through perihelion about the time of discovery near the earth. In that case its distance from the sun would be nearly the same as the distance of the earth from the sun. Or the object might be a new but tiny satellite to the earth, giving us a second moon. In fact in that case its distance from the earth would have been about 1.5 times the distance of the moon and its period of revolution about five months. Application of the new method of solution readily revealed that the latter possibility is definitely excluded and that the object is a planet moving in a cometary orbit. It may have been observed years ago as a comet. Its importance lies in the fact that it can approach closer to the earth than Eros and therefore furnishes the best opportunity for more accurate determination of the distance of the sun from the earth.

Trial of a projection method for measuring astronomical photographs: FRANK SCHLESINGER and ARTHUR L. BENNETT. In this method of measuring, a strong light is placed behind the photographic plate and is kept in the line of collimation of the measuring microscope. The images of the plate and of the cross wires are then thrown upon a white mat surface with a magnification of about thirty. The microscope being moved with reference to the plate by means of a long and accurate micronometer screw, the settings are made by superimposing the image of the cross wires upon the star images. A large number of plates were measured in this way and also by the usual method; the two results are equally accurate, or if there is any difference it is in favor of the projection method. The new method has the advantages of being a little more rapid and far less tiring.

Curvature theorems in dynamics (illustrated): EDWARD KASNER.

A deaf speaker: FREDERICK BEDELL (introduced by Ernest Merritt). The microphone, phonograph and radio, and the loud speaker which they operate have reached a high stage of development for the entertainment and education of people with normal hearing, and the benefits of this development have been far-reaching. There are, however, in this country some fifteen million people who on account of defects in hearing are completely debarred, or to a large extent debarred, from enjoying these benefits. The need, therefore, is evident for a "deaf" speaker which will give audition to the deaf similar to the audition given by a "loud" speaker to those who have normal hearing. Such a speaker for the deaf, utilizing bone conduction from a vibrating applicator applied to the teeth or bony structure of the head, has been developed. Sound vibrations are thus detoured around the middle ear, where defects causing deafness are usually located, and are picked up by the bone-encased fluid of the inner ear. Special attention has been paid to matching mechanical impedance, so that the vibrations are given proper force and amplitude for transmission through the bone, and to controlling frequency response so as to give best audition for different types of deafness. In this way people who have not heard for years have been able to hear.

On the theory of ferromagnetism: PAUL S. EPSTEIN. According to Heisenberg the ferromagnetic phenomena are due to the magnetic spin moments of the valency electrons. In spite of some work done by Bloch and others, the theory was not sufficiently carried through mathematically, so that there remained doubts whether the spin moments are a sufficient cause of ferromagnetism. The author succeeded in finding expressions for the probability of a given magnetic moment of a crystal which are rigorous within the simplifying assumptions of the theory. They permit to set up the criteria for a substance becoming ferromagnetic and to say positively that, under certain conditions, the spin moments can produce ferromagnetism.

(To be concluded)

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TÔHOKU IMPERIAL UNIVERSITY: *Science Reports.* Second Series (Geology). Vol. xiii. Pp. 168. 5 figures. 5 plates. The University. Yen 11.70.

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SCIENCE

VOL. 75 FRIDAY, JUNE 3, 1932 No. 1953

The Radiosensitiveness of Cells and Tissues and Some Medical Implications: DR. ARTHUR U. DESJARDINS ... 569

Obituary:
James William Toumey: PROFESSOR HENRY S. GRAVES ... 575

Scientific Events:
British Solar Eclipse Expedition to Canada; Investigation of Cosmic Radiation; Conference of the International Standards Association; Experimental Forests Established in Minnesota; Awards of the American Medical Association for Exhibits at the New Orleans Meeting; Awards to Engineers in England ... 577

Scientific Notes and News ... 580

Discussion:
Leidy's Cretaceous Reptiles of the United States: DR. JOSEPH LEIDY, II. *Significance of Baer's Law:* PROFESSOR RICHARD JOEL RUSSELL. *Light a Factor in Rancidity:* MAYNE R. COE. *Twisted Tree Trunks on the Gaspé Peninsula:* BEIRNE B. BRUES ... 583

Scientific Books:
Weyl's Theory of Groups and Quantum Mechanics: PROFESSOR EDW. U. CONDON ... 586

Scientific Apparatus and Laboratory Methods:
An Inexpensive Micrographic Projector: CHARLES G. DOBROVOLNY. *Device for Washing Microscopical Tissues:* DON MEDARIS ... 588

Special Articles:
The Evolution of a Carotid Sinus Reflex and the Origin of Vagal Tone: DR. BRENTON R. LUTZ and DR. LELAND C. WYMAN. *A Laboratory Experiment in Animal Behavior:* DR. J. H. WELSH ... 590

The National Academy of Sciences:
Papers presented at the Washington Meeting ... 592

Science News ... 8

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THE RADIOSENSITIVENESS OF CELLS AND TISSUES AND SOME MEDICAL IMPLICATIONS[1]

By Dr. ARTHUR U. DESJARDINS

SECTION ON THERAPEUTIC RADIOLOGY, MAYO CLINIC, ROCHESTER, MINNESOTA

CASUAL reading of contemporary medical records bearing on the action of roentgen rays and radium often gives the impression that little of such action is known, in spite of the fact that substantial or conclusive experimental data are available to indicate or to clearly establish the nature of such action. In some cases indeed the experimental indications are absolute. In other cases the experimental evidence may be inadequate, but the clinical data may be sufficient to suggest the probable effect of irradiation. It is true that many problems relating to radiotherapy are still the subject of controversy and that the large number of experiments which have been made has yielded only partial answers to many questions. Nevertheless, the facts already brought to light are sufficiently numerous to provide an imposing, although admittedly incomplete, scientific background. Unfortunately, the evidence furnished by experiments on animals and clinical observation has never been analyzed and correlated, and much of it has been lying on library shelves, buried in medical or other journals which are seldom read. Even among medical radiologists knowledge of the experimental background is not widely diffused.

The law based on the extensive investigations of Bergonié and Tribondeau (1904–1907), according to which young or immature cells are more radiosensitive than old or adult cells, has been generally recognized and has long been regarded as the essential foundation of radiotherapy. Numerous experiments have shown that direct irradiation of the pregnant uterus or of the young soon after birth causes retardation of growth of the skeleton and of various organs, including the brain. The degree of such effect varies with the dose, the age of the animal and the natural life cycle of the species. The cells and tissues of a given species rapidly become less sensitive as the animal emerges from the early phase of its existence, during which growth is a prominent feature. Indubitable as is the relation of the age of cells to radiosensitiveness, analysis of the experiments made to test the susceptibility of different organs and tissues brings out the even more important fact that each variety of cell in the body has a specific sensitiveness, or rather a specific range of sensitiveness, to radiation. This is not intended to imply that all cells of one kind, such as lymphocytes or squamous epithelial cells, react in precisely the same way to a given dose of rays. A certain measure of variation in reaction must necessarily occur, because different cells of the same kind are struck by the rays while in different stages of metabolism. Other still unknown factors also may play a part. However, if allowance be made for such variation, and if reaction time be taken as a criterion, the specific sensitiveness of each kind of cell looms up as the dominant single fact of radiology and deserves to be recognized as a law. And, yet, if we may judge by present-day writings, the existence of such a law and of its medical and biological implications is not at all realized. For years much has been made of the dogma that pathologic cells are more radiosensitive than normal cells of the same kind, but, as Lazarus-Barlow and others have shown, the foundation on which this dogma rests is tenuous and insecure. The physiologic condition of cells undoubtedly has some influence on their sensitiveness, but, as I shall bring out presently, such influence is small as compared with the specific natural susceptibility of each variety of cell. Although the factors responsible for such specificity have not yet been determined, the sensitiveness peculiar to each kind of cell appears to be related chiefly to the natural life cycle. Thus the lymphocytes, whose metabolic cycle among human cells is the shortest, are also the most radiosensitive, and the nerve cells, whose life cycle is the longest, are also the most resistant to irradiation. But to this question as to many others the final answer has not been given.

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[1] Abridged form, as read before the summer meeting of the American Association for the Advancement of Science, Pasadena, California, June 15 to 20, 1931.

When a living tissue or organ is exposed to roentgen rays or radium, a more or less important proportion of cells may subsequently exhibit temporary inhibition of metabolic activity or complete and permanent disintegration, or may not show any deleterious effect. Moreover, if the time intervening between irradiation and perceptible reaction is taken as a criterion, it will be found that certain species of cells react more rapidly than others to a given dose, or the degree of reaction to the same dose is greater for some kinds of cells than for others. According to our present knowledge cells may be classified, according to their radiosensitiveness, in the following order:

Lymphoid cells (lymphocytes).
Polymorphonuclear and eosinophile leukocytes.
Epithelial cells:
  (1) basal epithelium of certain secretory glands, especially the salivary glands;
  (2) basal epithelium (spermatogonial cells) of the testis and follicular epithelium of the ovary;
  (3) basal epithelium of the skin, mucous membranes, and of certain organs, such as the stomach and small intestine;
  (4) alveolar epithelium of the lungs and epithelium of the bile ducts (liver), and
  (5) epithelium of tubules of the kidneys.
Endothelial cells of blood vessels, pleura and peritoneum.
Connective tissue cells.
Muscle cells.
Bone cells.
Nerve cells.

Although the difference in susceptibility between the most sensitive and the least sensitive varieties of cells is considerable, none of the cells is wholly invulnerable to radiation; all cells, whatever their variety, may be destroyed or injured if exposed to a sufficiently large dose of rays, especially if doses within the therapeutic range are disregarded.

RADIOSENSITIVENESS OF DIFFERENT SPECIES OF CELLS

Lymphoid cells: Of the different kinds of cells which make up the tissues and organs of the body, the most susceptible by far are the lymphocytes. This important fact was brought to light by the early and extensive experiments of Heineke (1903, 1904, 1905) and has since been fully confirmed by the subsequent investigations of Warthin (1906), Krause and Ziegler (1906–1907), and Fromme (1917), Hartmann (1920), Jolly (1924), Tsuzuki (1926), Piepenborn (1929) and others. When the entire body of different species of animals was exposed to roentgen rays, Heineke found that most of the tissues and organs remained unaffected, but that the spleen, lymph nodes, intestinal lymph follicles, circulating blood, bone-marrow and all agglomerations of lymphoid cells showed a more or less pronounced destruction of lymphocytes. The degree of such destruction was proportional to the dose of rays and varied with the interval between irradiation and death. In the spleen, lymph nodes and other lymphoid structures the destruction of lymphocytes started around the germinal center and gradually extended toward the periphery of the follicles. As the number of intact lymphocytes diminished the stroma became prominent, and often this feature was so pronounced that the follicles could be recognized only by the blood vessels and the concentric arrangement of the stroma. Heineke observed such destruction of lymphocytes as early as two hours after irradiation. The extent and duration of this destructive phase depended on the intensity of irradiation, continued for several days, and was accompanied by a progressive reduction in volume or atrophy of the affected structures.

As described by Heineke, such destruction is characterized by disorganization and fragmentation of the nuclear chromatin, scattering of the fragments of chromatin between the remaining intact cells and in the reticular spaces, where the fragments gather into clumps or balls. Then the clumps or balls of degenerate chromatin are gradually taken up by some of the reticular cells which assume a phagocytic property and swell as the amount of ingested chromatin débris increases. The disposal of chromatin material from the destroyed cells continues until all such material has undergone phagocytosis. The nuclear débris ingested by the phagocytes apparently undergoes intracellular digestion, because the number and size of the ingested fragments diminish steadily. Some hours later, the phagocytic reticular cells themselves begin to disappear. After a single massive irradiation or repeated moderate doses, all the lymphocytes may be destroyed, but after a single small or moderate dose, a certain proportion of the cells appear to resist the action of the rays. From one to three weeks after exposure, if the irradiation has not been sufficiently intense to destroy all the lymphocytes, more or less regeneration of the lymphoid tissue may be observed and complete cellular restoration may occur. Two or three days after exposure to roentgen rays, degenerative alteration of other cells, notably the polymorphonuclear leukocytes and eosinophiles, also becomes perceptible, and many of these cells disappear from the splenic pulp and bone marrow.

Warthin's description of the effect of roentgen rays on the lymphoid structures corroborates the observations of Heineke in every particular, except that, by examining the tissues soon after irradiation, Warthin found unmistakable evidence of the disintegration of lymphocytes within fifteen minutes after exposure of the animals to the rays, and the cellular degeneration continued for several days. Similar effects were obtained with radium by London (1903), Heineke (1904), London (1905), Thies (1905) and Lazarus-Barlow (1922). Rudberg (1907), Aubertin and Bordet (1909), Arella (1910), Regaud and Crémieu (1912) and others have likewise shown that roentgen rays and radium exert precisely the same influence on the small round cells of the thymus gland, and their work strongly supports Hammar's conclusion that the small cells of the thymus gland are indeed lymphocytes. Others, notably Senn (1903), Heineke (1903, 1905), Guilloz and Spillmann (1904), Aubertin and Beaujard (1904, 1905, 1908), Brown (1904), Bryant and Crane (1904), Capps and Smith (1904), Helber and Linser (1905), Benjamin, von Reuss, Sluka and Schwarz (1906), Aubertin and Delamarre (1908), Taylor, Witherbee and Murphy (1919), Russ (1919, 1921) and Leitch (1921), have proved conclusively that the lymphocytes in the circulating blood are equally sensitive to irradiation and also destroyed in large numbers by exposure to roentgen rays or radium.

Epithelium of the salivary glands: Next to the lymphocytes in point of radiosensitiveness are the basal epithelial cells of the salivary glands. Actually these cells are more sensitive to radiation than the polymorphonuclear and eosinophilic leukocytes. This is evidenced by the fact that, whereas microscopically perceptible changes in the two latter varieties of cells can seldom be found within the first six hours after exposure to the rays, clinical signs of salivary reaction can usually be observed in from three to six hours after irradiation. These signs consist in swelling, redness, and tenderness in the region of the irradiated glands and, when bilateral, may stimulate the salivary phase of mumps. If all the glands on both sides have been exposed to the rays, the foregoing clinical signs may be rapidly followed by decrease in salivary secretion, often leading to dryness of the mouth lasting from a few days to two or more weeks. Such reaction of the salivary glands is characterized by mucoid degeneration of the basal epithelium. The cells swell, the excretory ducts become occluded, and the secretion accumulates within the glands; hence swelling and tenderness of the glands, and dryness of the mouth. Following a single irradiation salivary reaction is always transient; after a time, usually from twenty-four to seventy-two hours, the acute phase of the reaction subsides and the clinical signs gradually abate. Following repeated irradiation, however, the secretory function of the glands may cease and dryness of the mouth may persist for a long time. Such effects occur only when the glands on both sides have been exposed to the direct action of the rays. Salivary reaction does not occur when other parts of the body are irradiated, and exposure of the glands on one side causes a reaction on that side only. When the reaction is unilateral, dryness of the mouth is seldom noticed, undoubtedly because the glands on the opposite side furnish a sufficient quantity of saliva to lubricate the oral mucosa. The experiments of Lazarus-Barlow (1922) and of Mottram (1923) indicate that epithelial cells which produce mucus are much more sensitive to irradiation than other epithelial cells. The first effect is mucoid degeneration with excessive and abnormal production of mucus, followed by arrest of mucus formation. This has been shown to occur in the intestine, and the behavior of the salivary glands under irradiation make it seem likely that the mucus-producing cells in the epithelial lining of these glands are similarly affected by the rays.

Epithelium of the testis and ovary: The testis is not so sensitive as some of the leukocytes or the salivary glands, but with the exception of these is the most sensitive structure in the body. The radiosensitiveness of the organ is due to susceptibility of the spermatogonial cells, which are affected deleteriously even by a moderate dose of roentgen rays. The cells of Sertoli are relatively resistant to irradiation, and this fact tends to support the view that they supply nourishment to the basal layer of seminal cells, the spermatogonia. The spermatocytes of the first and second order, as well as the spermatids and mature spermatozoa, are distinctly less sensitive than the spermatogonia and are affected only by larger doses. Even so, much of the cellular degeneration is probably secondary to the direct action of the rays on the basal cells. After a sufficiently large dose, degeneration of spermatogonia proceeds to complete disintegration. This is accompanied by failure of the cells to evolve into spermatocytes and mature spermatozoa, and the final result is permanent azoospermia. After a dose insufficient to cause permanent azoospermia, a certain proportion of the spermatogonia may be able to survive and serve as a nucleus for histologic regeneration and functional restoration. Large doses repeated at comparatively short intervals are almost certain to induce permanent castration. The interstitial tissue, on the other hand, is much more resistant and is not perceptibly influenced by ordinary therapeutic irradiation.

The radiosensitiveness of the ovary is essentially the same as that of the testis, and the cells to which the specific susceptibility of the gland is due are the ova and the epithelium of the follicles. The sensitiveness of different follicles varies according to the stage of development. Depending on the dose of rays to which the ovary has been exposed or to the number of times a given dose has been repeated, the effect of irradiation may be disintegration and disappearance of a certain proportion of the follicles or complete and permanent destruction of every follicular structure. A certain proportion of the primordial follicles may escape if the dose has been small. Moreover, the steps in the reaction of the follicles are analogous to those of spontaneous physiologic atresia.

Epithelium of the skin, mucous membranes and gastro-intestinal tract: The skin can tolerate with impunity a considerable single dose of roentgen rays, but when the limit of tolerance is exceeded it may undergo a series of reactive changes. The first clinical manifestation of excessive irradiation is a readiness of the hair to fall out in the exposed territory. After a still larger dose, not only does epilation occur, but varying degrees of reactive inflammation of the skin may take place. Dermatitis may appear as a slight erythema lasting a few days and followed by pigmentation corresponding to the exposed area; as a more pronounced, bright red erythema with a sensation of heat, followed by the formation of vesicles and later by itching, exfoliation of the epidermis and deep pigmentation; or, in extreme cases, as an intense, painful erythema, with or without fever, and followed by more or less extensive ulceration of the entire thickness of the skin. Mild radiodermatitis may not leave any permanent marks beyond slight atrophy of the irradiated area of skin, provided the inflammatory reaction results from a single exposure. When such reaction appears after the same area of skin had been exposed several times, it is likely to be followed, from one to three years later, by telangiectasis. The sudoriferous and sebaceous glands of the irradiated skin also undergo degenerative changes. Radiodermatitis accompanied by the formation of vesicles is followed by more extensive desquamation or by the actual formation of small, rounded or large, irregular cutaneous scars. When severe radiodermatitis is followed by ulceration, the ulcers are slow to heal. This is due partly to the peculiar character of injury produced by irradiation and partly to secondary infection which so commonly complicates the ulceration.

The sensitiveness of the epithelium of mucous membranes is much the same as that of the skin. Excessive single irradiation causes first anesthesia, then dryness, redness from hyperemia and edema. Depending on the dose, these clinical manifestations may abate and disappear or may be followed by ulceration. The radiosensitiveness of specialized mucous membranes, such as the mucosa of the stomach and intestine varies with each structure. Irradiation of the stomach causes temporary reduction in the secretion of gastric juice, and this affects the production of hydrochloric acid and pepsin. If the stomach is exposed repeatedly at relatively short intervals, the gastric acidity and pepsin fall lower and lower, and this may continue for weeks or months. If the exposures were repeated indefinitely the secretory activity of the gastric mucosa might be completely and permanently arrested. The susceptibility of the intestine varies in its different parts. The mucosa of the colon is relatively insensitive to the action of the rays; at least, it is much less sensitive than that of the small intestine. The most sensitive portion of the mucosa of the digestive tract is that of the duodenum and jejunum, which may be irritated by doses insufficient to disturb the overlying skin. When the upper half of the abdomen is exposed to a therapeutic dose of roentgen rays, anorexia, nausea and vomiting often follow within a few hours, and diarrhea may appear several days later. Exposure to excessive doses, such as have been employed in many experiments on animals, causes mucoid degeneration of the intestinal epithelium, hyperemia, edema of the mucosa and submucosa, and such changes may be followed by desquamation of the epithelium. According to the severity of reaction, the epithelium may regenerate or the breach in the mucosa may be repaired by connective tissue.

Epithelium of the lungs, liver and kidneys: The lungs, liver and kidneys are only moderately sensitive to irradiation. Grossly excessive doses may cause cellular degeneration and reactive inflammation, and the injury may be repaired by connective tissue, which may lead to slight or pronounced impairment of function.

Endothelium: The radiosensitiveness of the endothelium of blood vessels, pleura and peritoneum is approximately the same as that of the skin. The effect of excessive irradiation is swelling of the endothelial cells, which degenerate and desquamate into the lumen of the vessel. The media also may swell. As the acute reaction subsides the cellular injury may be repaired by hyperplasia of adjacent cells or the entire wall of the vessel may thicken, and the lumen may be narrowed or completely obliterated.

Connective tissue, muscle, bone and nerve tissue: The sensitiveness of these different tissues decreases in the order named. Bone and nerve cells are the most resistant of all cells, but it must not be inferred that they are wholly insensitive to irradiation. A sufficient dose of roentgen rays or radium can readily retard the development of bone in a young rapidly growing animal, and even the mature bones of adult animals may be devitalized. Nerve cells can tolerate comparatively large doses without giving perceptible evidence of direct injury. The cellular changes in nerve tissue observed after irradiation appear to be indirect and secondary to action of the rays on more sensitive elements, such as the endothelium of the blood vessels which supply the nerve tissue.

Stimulating effect of irradiation: For years the legend that roentgen rays or radium, under certain conditions of dosage, may increase the growth and metabolism of cells has gained wide circulation. This notion has arisen from the attempt to apply to these agents the so-called Arnt-Schulz law, according to which small doses stimulate and large doses depress cellular metabolism. Based on pharmacologic grounds, this doctrine has not been generally accepted, even by pharmacologists. The attempt to apply it to the action of roentgen rays is unwarranted, because the experimental evidence on which it is based is extremely meager and apparently invalid. That a measure of acceleration in cellular metabolism may occur under certain conditions has been shown repeatedly both in animals and plants, but such unusual acceleration is a transient phase of reaction and is invariably followed by more or less pronounced inhibition of function and cellular degeneration. Another factor in the propagation of this notion of a stimulating action of the rays has been the regression of pathologic lesions after exposure to small doses of roentgen rays. Such regression is best explained by the exceptional radiosensitiveness of certain varieties of cells. As the result of primary degeneration of certain cells a secondary and indirect stimulation may sometimes be observed. Such is the increase in connective tissue cells in certain tissues and organs after repeated irradiation; the connective tissue is laid down to replace other cells which the rays have caused to undergo degeneration. Any primary or direct acceleration of cellular metabolism must be regarded as an effort of the cell to counteract or compensate for the noxious influence of the rays; in other words, it is purely a defense reaction. Continued acceleration of metabolism can not be induced by roentgen rays or radium, which always cause degenerative changes or have no effect whatever. Irradiation of certain tissues, such as the skin, repeated over a long period of time may cause hyperplasia of the epithelium, and this in turn may lead to malignant transformation. This is not stimulation in the sense here employed, but the alteration of a normal to an aberrant function due to chronic irritation.

Comparative influence of rays of different wave-length: Roentgen rays and radium have the same general effect on living tissue. Such variations as may be observed can be accounted for by difference in the methods of irradiation with each agent. Unfiltered radium buried in the substance of a tissue produces an intense destruction of cells immediately adjacent to the radioactive unit. The degree and extent of destruction can be modified at will by filtration. The conditions under which roentgen rays are generated prevent anything but external irradiation. If the effect of external irradiation with radium is compared with that of similar irradiation with roentgen rays, any variation attributable to difference in wave-length will be small; the greater part of the difference must be charged to variation in the total quantitative dose of each kind of energy. Quality of radiation plays a definite part in the effect, but this part is much smaller than the part played by quantity of radiation. To illustrate this further, I need only draw your attention to the difference of action between unfiltered roentgen rays of relatively long wave-length and rays of short wave-length generated at voltages of 80 and 200 peak kilovolts, respectively. A dose of the former beyond the tolerance of the skin to an area more than one inch in diameter is likely to result in ulceration, whereas a corresponding dose of rays of short wave-length seldom causes ulceration, but usually induces a dense brawny induration of the skin and subcutaneous tissues and adhesion of the underlying muscles.

OUTSTANDING MEDICAL IMPLICATIONS

To attempt to deal adequately with this phase of my subject would be to risk overtaxing your patience. I shall confine myself, therefore, to a brief outline of the more important medical relationships.

Radiotherapy for inflammatory conditions: Knowledge of the specific sensitiveness of different species of cells to roentgen rays or radium is of fundamental importance in the treatment of inflammatory lesions as well as in the diagnosis and treatment of certain neoplastic processes. It has long been known that many acute or chronic, suppurative or non-suppurative, inflammations are favorably influenced by roentgen rays or radium. In some of these conditions indeed irradiation has been found to be the therapeutic method of choice. Among the acute inflammations amenable to such treatment may be mentioned furuncle, carbuncle, lymphadenitis, pneumonia in certain stages, parotitis and erysipelas. The more acute the process the more quickly it responds to irradiation and the smaller the dose required. Exposure of such lesions at an early stage (phase of leukocytic infiltration) usually causes them to undergo rapid resolution. Irradiation at a slightly later stage (phase of beginning suppuration) hastens the suppurative process. In both cases, but especially in the former, the course of the inflammation is shortened and pain is quickly allayed. Usually, a single exposure to the rays is sufficient. Tuberculous lymphadenitis, tuberculosis of the cornea and iris, trachoma, actinomycosis, and many diseases of the skin may be cited as examples of chronic inflammation amenable to radiotherapy. In such conditions, however, treatment must be repeated at intervals for some time. The rate and mode of reaction of inflammatory lesions indicate that the rays act chiefly by destroying the infiltrating lymphocytes, the exceptional sensitiveness of which has already been pointed out. The rate of reaction of acute inflammations corresponds so closely to the rate at which normal lymphocytes are known to be destroyed by the rays that, even in the absence of other evidence, the analogy can not be regarded as a coincidence. Moreover, confirmatory evidence has been provided by frequent microscopic observation, in irradiated lesions of this kind, of lymphocytic destruction in every respect similar to that which was first observed and described by Heineke.

Leukocytic, and especially lymphocytic, infiltration is an early and prominent feature of most inflammatory conditions. Especially is this true in inflammations caused by bacterial infection. If it can be assumed that the leukocytes, which the organism mobilizes around the site of infection, represent an effort to localize the infection and get rid of the infectious material by phagocytosis or otherwise, it must be inferred that the infiltrating cells contain or elaborate within themselves the protective substances which enable them to neutralize the bacterial or other toxic products which give rise to the defensive inflammation. If these assumptions are well founded, it seems not unreasonable to deduce that irradiation, by destroying the infiltrating lymphocytes, causes the protective substances contained by such cells to be liberated and thus be made even more readily available for defensive purposes than they were in the intact cells. All the circumstances surrounding the behavior of inflammatory lesions after irradiation are in harmony with this view. The same process also undoubtedly plays an important part in the reaction of chronic inflammatory lesions, but in such cases the reaction is modified according to the degree of leukocytic infiltration on the one hand and to the amount of connective tissue on the other. This probably explains why the resolution and cure of chronic inflammations, such as those mentioned, require that irradiation be repeated at intervals for some time.

Radiotherapy and the genital glands: The radiosensitiveness of the genital glands is important from more than one point of view. The relative ease with which testicular or ovarian function can be abolished by irradiation furnishes a simple method of accomplishing this result whenever functional arrest is necessary or desirable. The method has seldom been applied to the male, but it is commonly employed in the female as an increasingly valuable method of treating hemorrhagic disturbances and fibromyoma of the uterus. Functional arrest of the ovaries indirectly causes atrophy of the uterus and of the fibroid tumors. Both in the male and female, roentgen rays or radium might well be utilized to castrate the feebleminded, a method which would remove the objection to surgical operation. The danger of sterilization to professional radiologists and non-professional technical assistants has long been realized. Fortunately, modern methods of protection, if applied, remove all danger from such employment.

Radiotherapy for benign and malignant tumors: The specific sensitiveness of different kinds of cells constitutes the most important single factor in the treatment of neoplasms. The value of roentgen rays or radium in different varieties of tumor depends mainly on this feature. The susceptibility of tumors to irradiation agrees closely with the radiosensitiveness of normal cells of the same kind as those from which the tumors are derived and of which they are largely composed. Thus, the inordinate hyperplasia of lymphoid structures which characterizes Hodgkin's disease, lymphosarcoma, and lymphatic leukemia retrogresses under irradiation at the same rate as normal lymphocytes are known to be destroyed by similar exposure. In fact, so striking is the parallel that irradiation is now being used daily as a means of distinguishing such conditions when their clinical features do not permit absolute identification. In some cases, indeed, the radiotherapeutic method of diagnosis is more accurate and dependable than microscopic examination.

The only tumor which approaches lymphoblastoma in susceptibility to irradiation is the embryonal carcinoma, or seminoma, of the testis, the radiosensitiveness of which corresponds to that of normal spermatogonial cells. This is the most common neoplasm affecting the organ and heretofore has often been mistakenly regarded as a variety of sarcoma. Primary and secondary growths of this kind retrogress rapidly and some disappear completely after irradiation. The reaction of mixed, or teratoid, tumors of the testis is less rapid and seems to vary with the proportion of spermatogonial epithelium entering into their structure.

Knowledge of the relative radiosensitiveness of different cells has enabled Ewing and others to distinguish a group of bone tumors from other neoplasms which affect the skeleton. Ewing has designated this tumor as endothelial myeloma, because endothelial cells are a prominent feature. Among the malignant tumors of bone they are the most sensitive to irradiation. In fact, the other malignant growths which attack bone can hardly be said to have any sensitiveness; rather they are noteworthy for their resistance. Endothelial myeloma, on the contrary, is distinctly sensitive, and large tumors of this kind melt away with astonishing rapidity. The only other bone tumor which is radiosensitive is the usually benign giant-cell tumor, but its reaction to irradiation is unlike that of any malignant neoplasm. Instead of being followed by rapid or slow, but steady regression, irradiation of such growths causes them to swell and become tender. The patient and the uninitiated physician may naturally conclude that exposure to the rays has stimulated the tumor to increased growth, and the limb may be unnecessarily sacrificed. Such inflammatory reaction is a transient phase which lasts two or three weeks and is followed by slow regression and repair of the tumor by deposition of new bone. This characteristic reaction of giant-cell tumor constitutes at once a valuable means of identification and treatment and furnishes additional evidence that tumors of this kind, at least at the outset, are not true neoplasms but chronic inflammatory lesions.

Many other examples might be mentioned, but the foregoing are sufficient to illustrate the important bearing on medical diagnosis and treatment of the radiosensitiveness of cells and tissues. Heretofore, for some reason, biologists have seldom made use of radiation for experimental purposes. As soon as they begin to realize its possibilities, they will find in the method a means of acquiring much valuable information, and such increase in knowledge will help to extend the diagnostic and therapeutic applications.

OBITUARY

JAMES WILLIAM TOUMEY

JAMES WILLIAM TOUMEY, D.Sc., D.For., professor of silviculture at the Yale School of Forestry, died at his home in New Haven on May 6, 1932. He was one of the pioneers and founders of American forestry. He was a great teacher and educator, a scientist of distinction, an author, and an influential leader in advancing the movement of forestry. He had been associated with the Yale School of Forestry from the time of its establishment in 1900. His part in building the school, in setting and maintaining high educational standards, and making the institution a force in the development of forestry in the nation can not be measured.

Trained as a botanist, he brought his extensive knowledge of plant science to bear on the problems of forestry. By his own study and experience he mastered the technical aspects of forestry and made a large contribution to the application of forestry principles to American conditions. His power as a teacher lay in his unflagging enthusiasm, in his personal interest in students and sympathetic understanding of their needs, and in his ability to stimulate individual effort on their part. He possessed high qualities as a scientific investigator, keen perception, unusual sense of values, originality and ingenuity in research, and persistence in carrying his studies to a conclusion. He had unfaltering faith in the work he was doing and in the value and necessity of forestry in our national life. He was ever optimistic and courageous in the face of obstacles and he possessed a spirit of devotion that won a following in all his enterprises.

While intense in the application of his efforts to teaching and research in his special field, his general interests were broad, as exemplified in his reading, his university associations, and his participation in public affairs. He was simple and straightforward in thought and in his dealing with men. He was tolerant of the opinions of others, but he swiftly detected pretense, sophistry and self-seeking. His general personality and kindliness won the affectionate regard of his students and made a host of other friends.

Professor Toumey was born in Lawrence, Michigan, on April 17, 1865. His youth was spent on the farm of his father, Dennis Toumey, and his early educational work was in the local schools. He prepared for college at the Decatur High School, but taught school for several years before entering the Michigan State Agricultural College, from which he graduated in 1889. In college he directed his chief efforts to the study of botany. His work was given recognition by an appointment as an instructor in the college in 1890, and by the degree of Master of Science in 1893.

In 1891 he was called to the University of Arizona where he remained until 1898, advancing by steps to a full professorship in botany. At the same time he held the position of botanist in the State Agricultural Experiment Station, under whose auspices he conducted his scientific research. He served as the acting director of the station in 1897–1898. During this period Professor Toumey made very distinctive contributions to plant science. He conducted investigations in the fields of taxonomy, ecology, physiology and pathology, and also in entomology. He did special work on the date palm and became widely recognized as an authority on cacti. He established a cactus garden at Tucson which has been continued by his successors. He built up a large cactus herbarium, drawing upon it to aid the plant collections of Kew and other institutions. In 1897 he visited England and personally assisted in the systematic arrangement of the collection at Kew. About twenty-five articles and bulletins remain as a record of his investigative work in Arizona.

Professor Toumey began his formal work in forestry in 1899 when he was appointed superintendent of tree planting in the Division of Forestry, U. S. Department of Agriculture. He was selected for the post because of his knowledge of trees and in recognition of the experimental work which he had already done in tree planting. His duties were to encourage reforestation and to cooperate with private owners. He traveled extensively, studying local problems in various regions and assisting individuals by direct advice and through numerous publications.

When the Yale Forest School was established in 1900 Professor Toumey was chosen as one of the two regular members of the staff. Forestry was new and untried in this country, and there was little instructional material applicable to American conditions. It was a period of building the first foundations both of forest education and of the science and practice of American forestry. In this work Yale played a prominent part and Professor Toumey's contribution was large.

When the dean of the school, Henry S. Graves, was called to Washington to take charge of the U. S. Forest Service in 1910, Professor Toumey succeeded him as head of the school, a post which he held until 1922. During this period he materially enlarged the endowments and the physical facilities of the school. He was responsible for the gift of the new central building, Sage Hall. He enlarged the forest properties of the institution and secured large accessions to the library. He himself donated a collection of some 2,500 specimens to the forest herbarium. Even more important, he developed and strengthened the educational work, adhering to high scholastic standards and ideals as essential in a professional preparation for forestry.

In 1922 he retired from the deanship and devoted his efforts to teaching and research. The last decade of his life was the richest in his personal contributions to the science of forestry. Many research projects which he had previously initiated were brought to fruition.

He directed his chief efforts to the study of forest tree seeds and seedlings, to the environmental factors affecting the life of seedlings, trees and stands, and to the application of the principles of silviculture in intensive practice. He developed the property owned by the school at Keene, New Hampshire, as an experimental and demonstration forest of first importance. He secured funds for additional land, bringing its area to about 1,500 acres or about two thirds of its projected size. During recent years he made the Yale Forest at Keene a center of his silvical studies and his practical experiments in silviculture, and on it conducted a summer camp, with a selected group of graduate students. Before his last illness he was able to complete a report describing the forest, the history of the operations upon it, and the practical results of management. The Keene Forest will always stand as a memorial of his work in forestry.

Professor Toumey contributed extensively to the literature of forestry. His "Seeding and Planting" and "Foundations of Silviculture" are standard works widely used as text and reference books by students in the forest schools and by others interested in forestry.[1] He was responsible for initiating at the School of Forestry a series of scientific bulletins, now comprising thirty-three numbers. Of these he was author or co-author of eight, and seven others were written by graduate students working under his direction. In addition he wrote extensively for the forestry journals and other periodicals. His bibliography covers a wide range of subjects, including articles of a scientific character, discussions of applied silviculture, forest taxation, watershed protection, forest economics and public forest policy.

Professor Toumey was called upon frequently for public addresses and for participation in public enterprises through committees and advisory boards or as an officer in technical and civic associations. In 1929 he was a member of the American delegation to the International Congress of Forest Experiment Stations at Stockholm, Sweden. He was granted the honorary degree of Doctor of Science by Syracuse University in 1920 and the honorary degree of Doctor of Forestry by the Michigan State College in 1927. He was a fellow of the Society of American Foresters, and a member of Sigma Xi, and of a large number of organizations engaged in advancing the interests of forestry and conservation.

In 1897 Professor Toumey married Miss Constantia Blake, of New Haven, who died in 1904, leaving a son, James W. Toumey, now a surgeon in New York. His second marriage was to Miss Nannie Trowbridge, of New Haven, in 1908.

His ashes will be taken to the Keene Forest, to which he was deeply devoted and which will be an appropriate sanctuary for his last resting place.

HENRY S. GRAVES

SCHOOL OF FORESTRY,
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SCIENTIFIC EVENTS

BRITISH SOLAR ECLIPSE EXPEDITION TO CANADA

ACCORDING to the astronomical correspondent of the London *Times*, preparations are well advanced for the observation of the total eclipse of the sun on August 31 by an expedition from the Royal Observatory, Greenwich. The eclipse will be visible only from North America and limited regions surrounding that continent, the path from which the sun will be seen totally eclipsed crossing Hudson's Bay, Quebec Province, and the northeastern states, where totality will last about 100 sec. The observers, Dr. John Jackson and Mr. C. R. Davidson, F.R.S., of the Royal Observatory staff, will proceed to a selected station near the town of Parent, in the Province of Quebec, on the Canadian National Railway, to observe the eclipse.

There is to be no attempt to solve the problem of the bending of light-rays as they pass the sun that has formed part of the program on the occasion of some recent eclipses, but the equipment is chosen for making photographic records of the corona that is seen surrounding the sun only during total eclipses, and of its spectrum and of that of the chromosphere or solar atmosphere for which these occasions are specially suitable. Photographs of the corona will be taken with a telescope that has an object-glass 6 inches in diameter and of 45 feet focal length, giving therefore an image of the sun 5 inches in diameter. This will be placed in a fixed horizontal position and fed by a rotating coelostat.

The spectra of the corona and of the chromosphere will be photographed with a telescope with object glass 7 inches in diameter, of 21 feet focal length, producing, therefore, an image of the sun 2.3 inches in diameter. The spectrum will be formed by a prism, whose effective angle is 45 degrees, placed before the object glass. Such photographs result in a series of parallel arcs, which are actually pictures of the edge of the sun formed by light of different wavelengths. It is hoped that these will enable a connection to be traced between the chromosphere and the corona, and a differentiation to be made between the individual rings, or layers, which it is believed make up these solar surroundings.

Apparatus is also being taken with which to photograph the spectrum of the chromosphere and of the corona in its red and infra-red region. This is a grating slit spectrograph, the sun's image being formed on the slit by a mirror 9 inches in diameter and of 10 feet focal length. Another spectrograph of a different type, the spectrum in this case being produced by a prism with refracting angle of 30 degrees, will be used to photograph certain groups of lines due to calcium, and then deduce their absolute relative intensities at different heights in the chromosphere. Use will be made of curved films in some of these operations to secure good definition over a considerable length of the spectrum and advantage will be taken of the new Ilford infra-red sensitive plates.

INVESTIGATION OF COSMIC RADIATION

ACCORDING to information from the Massachusetts Institute of Technology, it will participate this summer in the world-wide survey of cosmic radiation to be undertaken under the auspices of the Carnegie Institution of Washington.

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[1] *Seeding and Planting.* James William Toumey. John Wiley and Sons, New York, 1916. Revised by J. W. Toumey and C. F. Korstian, 1931.

Foundations of Silviculture. James William Toumey. John Wiley and Sons, New York, 1928.

The project, which calls for the establishment of some 20 scientific stations on six continents and in every zone except the Antarctic, is under the direction of Dr. Arthur H. Compton, of the University of Chicago.

Dr. Ralph D. Bennett, associate professor of electrical measurements at the institute, with the cooperation of Dr. J. L. Dunham of Harvard University, will undertake cosmic radiation studies in Alaska, California and Colorado. Dr. Bennett made preliminary radiation studies in Colorado last year and since then he has developed a portable counting tube apparatus. It is planned to set up this instrument at high altitudes in the Rocky Mountains for measurements of the stopping power of different materials for the particles which actuate the counting tube. Dr. Bennett has left Cambridge to join his party in the west.

During the investigations measurements of cosmic radiation will be carried on continuously, day and night, over a long period, to determine whether there is a diurnal variation. The survey will also make it possible to compare directly intensities of radiation at many points. These studies are expected to show definitely whether cosmic radiation is associated with terrestrial locality.

Dr. Robert B. Brode, of the University of California, visiting professor of physics at the Institute of Technology, will cooperate with Dr. Bennett and Dr. Dunham in measurements in the California mountains. In Colorado the party will have the assistance of Professor J. C. Stearns, of the University of Denver. Professor M. S. Vallarta, of the department of physics, will join the party of Professor Compton when it begins its investigations in the highlands of Mexico. Dr. Compton's party will also make measurements in Hawaii, Australia, New Zealand, Peru, the Canal Zone and in northern Canada in the vicinity of the north magnetic pole.

The Asiatic survey will be directed by Professor J. M. Benade, of Lahore, who will make investigations in Ceylon, Java and northern India. South African observations will be made by Professor S. M. Naude, of the University of Cape Town. Dr. E. O. Wollan, of the University of Chicago, will go to Spitzbergen and other European points. Dr. Allen Carpe, of New York, lost his life recently in the beginning of the cosmic radiation survey at the head of the Muldrow Glacier on Mt. McKinley in Alaska.

CONFERENCE OF THE INTERNATIONAL STANDARDS ASSOCIATION

ENGINEERS of eighteen nations met in Milan, Italy, on May 30 to open a series of technical conferences aimed to secure international uniformity in standards for airplane and automobile parts, cutting tools, iron and steel, and other subjects.

The conferences, to extend through the ninth of June, are under the auspices of the International Standards Association, which includes in its membership the national standardizing bodies of the United States, France, Germany, Italy and 14 other nations.

Ernest Wooler, chief engineer of the Timken Roller Bearing Company of Canton, Ohio, an American delegate, will discuss before the conference on ball and roller bearings the American proposal to replace the thousand different types and sizes now manufactured in the United States alone.

Subjects which will be studied by the conference on aeronautics in an effort to secure greater international uniformity in essential features of airplanes, are: direction of rotation of the engine, safety belts, propeller hubs, electric voltages aboard airplanes, floats for seaplanes, parts of the steering equipment and engine control levers, dimensions and arrangement of instruments, instrument dials, identification colors for pipe lines, screwed pipe connections and valves, screw threads and principles for the computation of rating of airplanes and engines.

Other conferences will be held on cutting tools, center heights and dimensions of shaft ends of electric motor and driven machines, shafting keys, fluid meters and sieves for testing purposes.

The countries which will be represented at the International Standards Association conferences through their national standardizing bodies are: Austria, Belgium, Czechoslovakia, Denmark, Finland, France, Germany, Holland, Hungary, Italy, Japan, Norway, Poland, Roumania, Russia, Sweden, Switzerland and the United States.

EXPERIMENTAL FORESTS ESTABLISHED IN MINNESOTA

THREE field laboratories, comprising a total of approximately 5,396 acres, have been set aside as experimental forest areas within the Chippewa and Superior National Forests in Minnesota by the U. S. Forest Service. These areas were chosen after a careful study as being representative of the various types and conditions found in the forested area of Northern Minnesota.

The Cutfoot Experimental Forest is located approximately twenty-four miles from Deer River and is well stocked with thrifty, growing timber which is largely Norway and jack pine, although other types are also represented. The Pike Bay Experimental Forest lies approximately six miles southeast of Cass Lake. It is predominantly an aspen-hardwood type, but includes a small area of virgin white and Norway pine.

The Kawishiwi Experimental Forest, comprising 2,635 acres, is about thirteen miles southeast of Ely, Minnesota, within the Superior National Forest. The three most important timber types on the Superior National Forest, and in the region immediately surrounding that forest, are represented within the experimental area. This portion of Minnesota is a distinct climatic region and the rock outcrop soil is unique in the Lake States. The result of studies made elsewhere in the Lake States Region can not be definitely applied to this large area of forest land and it is largely for the purpose of studying the proper methods of handling the jack pine, black spruce and aspen types that this experimental forest was established.

The federal forest research work in the Lake States Region is handled by the Lake States Forest Experiment Station which is maintained by the Federal Government in cooperation with the University of Minnesota at St. Paul. A branch station has been maintained for several years on the Chippewa National Forest. The designation of the Cutfoot and Pike Bay Experimental Forests will make it possible to concentrate the studies within the two areas, thus permitting a more efficient conduct of the studies and a more effective demonstration to the timberland owners in the vicinity who are interested in managing their own timber lands for the permanent production of timber. A branch station has also been established on the Superior National Forest and the designation of the Kawishiwi Experimental Forest is in furtherance of the research work at this branch station.

The Lake States Forest Experiment Station also maintains branch stations at Ruse, Michigan; Roscommon, Michigan (a fire studies station in cooperation with the State of Michigan); in Buffalo County, Wisconsin (for the study of erosion), and in North Dakota for the development of planting technique on the prairie regions of that state.

AWARDS OF THE AMERICAN MEDICAL ASSOCIATION FOR EXHIBITS AT THE NEW ORLEANS MEETING

CLASS I

AWARDS in Class I are made for exhibits of individual investigations, which are judged on the basis of originality and excellence of presentation. According to the report in the *Journal* of the American Medical Association they were:

The gold medal to Frank A. Hartman, C. W. Greene, J. J. Maisel and G. W. Thorn, University of Buffalo, for original investigative work on the development and use of a hormone from the suprarenal cortex and excellence of presentation.

The silver medal to C. W. Emmons, College of Physicians and Surgeons, Columbia University, New York, for original work on the variations in ringworm fungi and excellence of presentation.

The bronze medal to J. A. Bargen, P. W. Brown and H. M. Weber, Mayo Clinic and Mayo Foundation, Rochester, Minnesota, for original investigation of diseases of the colon and excellence of presentation.

Certificates of Merit, Class I, were awarded to the following:

To Abraham Levinson, Chicago, for exhibit illustrating continuation of investigations on the cerebrospinal fluid.

To Alton Ochsner, Earl Garside and Ambrose Storck, department of surgery, Tulane University Medical School, New Orleans, for exhibit illustrating the use of digestive ferments in prevention of adhesions.

To Sidney J. Wilson and Simeon H. Hulsey, Fort Worth, Texas, and Fred D. Weidman, Philadelphia, for exhibit illustrating excellent studies on chromoblastomycosis in Texas.

In addition, the following exhibit is deemed worthy of Honorable Mention:

That of John W. Towey, Powers, Michigan; Willis H. Huron, Iron Mountain, Michigan, and Henry C. Sweany, Chicago, for exhibit on occupational sensitization to fungus spores found in maple bark.

CLASS II

Awards in Class II are made for exhibits which do not exemplify purely experimental studies and which are judged on the basis of excellence of correlating facts and excellence of presentation. They were:

The gold medal to Max Ballin and Plinn F. Morse, Harper Hospital, Detroit, for excellence in presentation of exhibit on parathyroidism.

The silver medal to L. G. Rowntree and C. H. Greene, Mayo Clinic and Mayo Foundation, Rochester, Minnesota, for excellence of presentation of exhibit of comprehensive study on Addison's disease.

The bronze medal to Ernest Carroll Faust, department of tropical medicine, Tulane University Medical School, New Orleans, for excellence of presentation of exhibit on human helminth infections.

Certificates of Merit, Class II, were awarded to the following:

To Chevalier Jackson and Chevalier L. Jackson, Temple University School of Medicine, Philadelphia, for excellence of presentation of exhibit illustrating tumors of the lungs and tracheobronchial tree.

To Frank C. Neff, D. N. Medearis and Margaret Anderson, department of pediatrics, University of Kansas School of Medicine, Kansas City, for excellence of presentation of exhibit illustrating a study of the newly born.

To Henry F. Vaughan, Detroit Department of Health, Detroit, for excellence of presentation of exhibit illustrating plan of medical participation of the general practitioner in a public health program.

In addition, the following exhibits are deemed worthy of Honorable Mention:

That of Francis Clark Grant, University Hospital, Philadelphia, for excellence of demonstration of exhibit on ventriculography.

That of O. E. Denney, National Leprosarium, Carville, Louisiana, for exhibit on leprosy. (This work has been recognized by awards at previous scientific exhibits of the American Medical Association.)

The Committee on Awards commended especially the group exhibit of the Mayo Clinic and Mayo Foundation as a model of presentation, the excellent demonstrations given in the special exhibits on poliomyelitis, on cancer and on physical therapy.

A special Certificate of Merit was awarded to the American Society for the Control of Cancer for a cooperative exhibit on cancer as the best exhibit in the educational (national organizations) classification.

AWARDS TO ENGINEERS IN ENGLAND

IT is announced in *Nature* that the British engineering societies have made awards as follows:

> The Council of the British Institution of Civil Engineers has made the following awards for papers read and discussed at the ordinary meetings during 1931–32: The Telford Gold Medals to Dr. C. F. Jenkin, emeritus professor of engineering science in the University of Oxford, and to Sir Bernard D'O. Darley, of Bahawalpur, India; the Stephenson Gold Medal to B. G. White, London; a Telford premium jointly to H. C. Whitehead, Birmingham, and F. R. O'Shaughnessy, Birmingham; Telford premiums to Raymond Carpmael, London, H. J. Deane, London, John Goodman, Skipton; a Manby premium jointly to W. F. Stanton, Bishops Castle, and A. G. Le Clercq, Walton-on-Thames; a Trevithick premium to W. C. Ash, Vizagapatam, India.
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> The Council of the British Institution of Electrical Engineers has made the following awards of premiums for papers read during the session 1931–32, or accepted for publication: Institution premium to J. Bruce; Ayrton premium to F. Lydall; Fahie premium to H. Kingsbury and R. A. Goodman; John Hopkinson premium to H. W. Clothier; Kelvin premium to Professor W. M. Thornton and Dr. W. G. Thompson; Paris premium to E. W. Dickinson and H. W. Grimmitt; extra premiums to H. Blades and A. C. MacQueen; R. O. Kapp and C. G. Carrothers; Dr. F. Luschen, H. Pearce and T. T. Evans; E. A. Watson, Major E. H. E. Woodward and W. A. Carne. Wireless section premiums: Duddell premium to T. L. Eckersley; extra premiums to B. S. Gossling, J. A. Ratcliffe, L. G. Vedy and A. F. Wilkins. Meter and Instrument Section premiums: Silvanus Thompson premium to Professor J. T. MacGregor-Morris and H. Wright; an extra premium to S. H. C. Morton.
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> Two awards of the Gold Medal of the Institution of Mining and Metallurgy, the highest distinction in its power to confer, have been made: (*a*) Sir Harold Carpenter, in recognition of his eminent services in the advancement of metallurgical science and technology; (*b*) Dr. Thomas A. Rickard, in recognition of his services in the general advancement of mining engineering, with special reference to his contributions to technical and historical literature. The following awards have also been made: The Consolidated Gold Fields of South Africa, Ltd., Gold Medal to P. J. Crowle for his investigations on ground movement and methods of support in deep mines, Kolar Gold Fields; The Consolidated Gold Fields of South Africa, Ltd., premium of forty guineas to Professor Bernard W. Holman for his work on flotation reagents; the William Frecheville Student's Prize of ten guineas to Gilbert F. Hatch for his paper on "Check Sampling of Diamond Drill Holes at the Trepca Mines, Jugoslavia."

SCIENTIFIC NOTES AND NEWS

THE Manson medal for tropical medical research, given triennially by the Royal Society of Tropical Medicine and Hygiene, has this year been awarded to Dr. Theobald Smith, who recently retired as director of the department of animal pathology of the Rockefeller Institute for Medical Research. The previous recipients of the Manson medal have been Sir David Bruce (1923), Senator Ettore Machiafava (1926) and Sir Ronald Ross (1929).

THE Lister Medal of the Royal College of Surgeons for distinguished contributions to surgical science has been awarded to Sir Charles Ballance, who will deliver the Lister Memorial Lecture at the college in 1933.

THE Hungarian Academy of Sciences has elected as foreign member Sir Arthur Eddington, Plumian professor of astronomy at the University of Cambridge and director of the Cambridge Observatory.

AT the annual convocation of McGill University on May 26, honorary degrees were conferred on Surgeon-General Robert Hugh Patterson, U. S. Army; Dr. Alfred North Whitehead, professor of philosophy at Harvard University, and Dr. J. S. Plaskett, director of the Dominion Astronomical Observatory.

THE presentation of the Mendel Medal will be made on June 7 at the commencement exercises of Villanova College to Francis P. Garvan, of New York, in recognition of his contributions to scientific progress. Former winners of the award have been Dr. John A. Kolmer, professor at the University of Pennsylvania; Dr. Albert F. Zahm, of the Congressional Library at Washington, and Dr. Karl F. Herzfeld, of the Johns Hopkins University.

PROFESSOR WILLIAM MUNDELL THORNTON, who holds the chair of electrical engineering at Armstrong College, Newcastle-on-Tyne, has been awarded the

Kelvin premium for 1932 in conjunction with Dr. W. G. Thompson for their paper on the absolute measurement of high electrical pressure.

Howard College, Birmingham, Alabama, has conferred the degree of doctor of laws on Dr. A. Richard Bliss, Jr., chief of the division of pharmacology of the College of Medicine of the University of Tennessee.

Dr. Leonard Thompson Troland, director of research of the Technicolor Motion Picture Corporation, lecturer in psychology at Harvard University, died on May 27. He fell from a cliff, near the summit of Mount Wilson, California. Dr. Troland was forty-three years old.

Dr. Francis E. Lloyd, professor of botany of McGill University, has been elected president of the Royal Society of Canada in succession to Sir Robert Falconer, retiring president, of the University of Toronto.

Paul J. Sachs, associate director of the Fogg Art Museum, was elected president of the American Association of Museums at the annual meeting of the association held in Cambridge from May 12 to 14. He succeeds Fiske Kimball, director of the Pennsylvania Museum of Art. Other new officers elected at the meeting were: *Vice-presidents,* Walter H. Siple, director of the Cincinnati Art Museum, and Hermon Carey Bumpus, trustee of the Children's Museum of Boston; *Secretary,* Alexander Wetmore, in charge of the U. S. National Museum. The following were reelected: *Vice-presidents,* Arthur C. Parker, director of the Rochester Museum of Arts and Sciences, and Charles R. Richards, executive vice-president of the New York Museum of Science and Industry; *Treasurer,* George D. Pratt, trustee of the American Museum of Natural History and the Metropolitan Museum of Art.

Dr. William H. Park was appointed at the recent New Orleans meeting to represent the American Medical Association on the council of the American Association for the Advancement of Science.

Dr. Allen D. Keller, professor of physiology and pharmacology in the University of Alabama School of Medicine, has been given a grant by the Committee on Scientific Research of the American Medical Association, to aid his investigations of brain-stem functions.

Professor Carlton C. Murdock, assistant professor of physics at Cornell University, has been made a full professor.

The following appointments to instructorships have been made in the School of Chemistry of the University of Minnesota for the coming academic year: in organic chemistry, Drs. P. D. Bartlett and C. F. Koelsch, now Research Council fellows at the Rockefeller Institute and at Harvard University, respectively; in chemical engineering, Fred Hovde, for the past three years Rhodes Scholar at the University of Oxford, and in analytical chemistry, E. B. Sandell, the present duPont Fellow at the University of Minnesota.

Nature states that at Jesus College, University of Cambridge, Dr. W. H. Thorpe has been elected a fellow. He has been a research fellow of the Rockefeller Foundation at the University of California and a member of the research staff of the Imperial Institute of Entomology. At St. John's College, Dr. L. Rosenhead has been elected a fellow. He entered the college with an open Strathcona Research Studentship for mathematics, and in 1930 was elected a senior research student of the Royal Exhibition of 1851.

Dr. Karl M. Dallenbach, who has been visiting professor of psychology at Columbia University for the past two years, returns to Cornell University next autumn as professor of psychology.

According to a news dispatch E. H. Magoon, a sanitary engineer for the Rockefeller Foundation, arrived at Managua, Nicaragua, on May 26 to assist in the government campaign against malaria. A severe epidemic followed the earthquake last year, the mortality being very high, and the Nicaraguan Minister of Public Health requested aid of the Rockefeller Foundation.

C. M. Heh, head of the department of agronomy at the University of Nanking, China, has begun a year's study at Cornell University. At Nanking he has been associated with the Cornell-Nanking cooperative plant breeding project.

Dr. Lafayette B. Mendel, Sterling professor of physiological chemistry in Yale University, delivered the annual Alpha Omega Alpha address in New Orleans on May 12. His subject was "Scientific Experiment and Medicine." Professor Mendel also addressed the students of the School of Medicine in Tulane University and at the Louisiana State Medical Center.

At the annual initiation of the Cornell Chapter of the Society of Sigma Xi, which was held on the evening of May 19, 72 members and associates were admitted to the society. The annual address was delivered by Dr. Maurice C. Hall, chief of the Zoological Division of the Bureau of Animal Industry, Washington, D. C., on the subject "Playing the Scientific Game."

PROFESSOR HUGH STOTT TAYLOR, chairman of the department of chemistry, Princeton University, will deliver the Edgar Marburg Lecture at the annual meeting of the American Society for Testing Materials in Atlantic City in June. This lecture was established in 1926 as a means of emphasizing the importance of that phase of the work of the American Society of Testing Materials which deals with the promotion of knowledge of engineering materials. The lecture commemorates the name of the society's first secretary-treasurer, who, through his development of technical programs over a period of sixteen years, brought wide recognition to the society as a forum for the discussion of various aspects of materials used in engineering fields. The subject of the lecture is "Fundamentals in the Problem of Resistance to Deterioration."

SIR ARTHUR KEITH will deliver the Stephen Paget Memorial Lecture at the annual general meeting of the Research Defence Society to be held in London on June 15.

A LECTURE on the Liversidge Foundation will be delivered by Professor A. V. Hill, Foulerton research professor of the Royal Society, on May 13, on "Chemical Wave Transmission in Nerve."

THE fourteenth annual meeting of the American Society of Mammalogists was held at the United States National Museum, Washington, from May 3 to 7. There were 122 members present from 14 states and one Canadian province, this constituting the largest attendance at an annual meeting in the history of the society. Forty papers on various phases of mammalogy were presented. One resolution was adopted asking federal and territorial agencies for a more adequate protection of the brown and grizzly bears of Alaska, and another urging the U. S. Biological Survey to cease the poisoning of wild life. The officers elected were: *President,* Marcus W. Lyon, Jr.; *Vice-presidents,* H. E. Anthony, T. S. Palmer; *Recording secretary,* H. H. Lane; *Corresponding secretary,* Robert T. Hatt; *Treasurer,* Mrs. Viola S. Snyder; *Directors,* class of 1932–1934, W. K. Gregory, R. M. Anderson, Chas. C. Adams, H. H. T. Jackson, Lee R. Dice. Edward A. Preble continues as chairman of the editorial board in charge of *The Journal of Mammalogy.* The next annual meeting will be held at the Museum of Comparative Zoology, Cambridge, Massachusetts.

THE American Society of Clinical Pathologists held their eleventh annual convention in New Orleans, Louisiana, from May 6 to 9. Dr. W. M. Simpson was inducted into office as president for the year 1932–33, and Dr. A. G. Foord, of Pasadena, California, was the president-elect. The Ward Burdick Award was given to Dr. B. Kline, director of laboratories in Mt. Sinai Hospital, Cleveland, for his contribution on the serological diagnosis of syphilis. Dr. R. R. Kracke was given the gold medal award for his demonstration of agranulocytic angina at the scientific exhibit of the society. The society officially dedicated the department of pathology of the Louisiana State University on May 9.

DR. J. EDWARD HOFFMEISTER, secretary of the New York State Geological Association, writes that the eighth annual meeting of the association was held at the University of Rochester on May 13 and 14. It was attended by 175 people representing 15 institutions in the state. On the first day the group visited the Genesee Gorge, the Irondequoit Bay and the Pinnacle Hills in order to study the geology of the Rochester region. This was followed in the evening by a dinner and dance. A feature of the dinner was an address by Professor Herman LeRoy Fairchild, one of the original fellows of the Geological Society of America. On the following day a trip to the Devonian south of Rochester was made. This included stops at the High Banks of the Genesee River at Mt. Morris, and the Genesee Canyon in Letchworth Park near Portage. Next year the association plans to visit the New York City region. Professors R. J. Colony and Marshall Kay, of Columbia University, were chosen president and secretary, respectively.

THE summer meeting of the Corn Belt Section of the American Society of Agronomists and the American Society of Plant Physiologists will be held jointly at the University of Wisconsin, on July 11, 12 and 13. All agronomists and plant physiologists whether members of the societies or not are invited to attend. Headquarters will be in the new agronomy building, and the program will be built around the environmental relations of plants utilizing the significant examples of the work in progress in field, greenhouse and laboratory to illustrate principles and technique.

A GREAT part of the University of Valencia was destroyed by a fire of unknown origin which broke out on May 12 in the natural history department. Damage was done to the extent of several million pesetas, the astronomical observatory and the faculties of natural history, physics and chemistry, with their valuable collections and laboratories, being destroyed. Six people were injured, three of them students who, with their professors, were engaged in saving the most precious volumes of the library when a glass roof fell in.

THE new Oceanographic Laboratory of the University of Washington in Seattle will be dedicated on the afternoon of June 15, with Dr. Robert A. Millikan as the chief speaker. The laboratories are situated on the shore of Lake Union at the foot of the campus, where ready access to the sea is obtained through the Lake Washington Ship Canal. The building is admirably equipped for research in oceanography, based on the fundamental sciences of physics, chemistry, botany and zoology. The Oceanographic Laboratories, besides the main laboratories to be dedicated in June, are composed of a research boat *Catalyst,* which is seventy-five feet long, Diesel driven, with a cruising radius of 2,000 miles, and the field laboratories at Friday Harbor in the San Juan Islands, comprising eight buildings of hollow tile construction, on 484 acres of land, with about two miles of shore line.

ACCORDING to the *Journal* of the American Medical Association ground was recently broken for the erection of a research laboratory at the plant of Merck and Company, Inc., Rahway. A south wing will be devoted to carrying on pure or fundamental research, for which three laboratories will be provided. Another laboratory will be fitted for biochemical research with an adjoining incubator room containing a sterilizer, incubator and other necessary equipment. In a pharmacologic laboratory the physiologic action of various chemicals will be investigated. There will also be a laboratory for micro-analysis, a microbalance room, an ordinary balance room and an ice room. The north wing will contain a large chemical laboratory suitable for twelve chemists carrying on applied research and development work. The central section will contain, among other things, a library.

ACCORDING to *The British Medical Journal,* an Alfred Fripp Memorial Fellowship, endowed with the sum of £7,000, has been established at Guy's Hospital for promoting the advancement of knowledge and research in psychology through the study of children in health and disease. The fellowship will be awarded by a board of electors consisting of the physician for diseases of children, the superintendent and the dean of the medical school as *ex-officio* members, and five others coopted by the *ex-officio* members. It will be open to either sex, but candidates must be unmarried, not more than 30 years of age, and be qualified to practice medicine or surgery; they will be expected to submit with their application a scheme of advanced study or research work. The appointment will be whole-time—it may be held concurrently with a demonstratorship—for a period of two years, which may be extended for a further period not exceeding three years at the discretion of the board of electors. The Fripp Fellow will be allowed opportunities for study in the children's department of the hospital, and the salary will be £300 per annum.

Nature reports that the amalgamation of the Optical Society and the Physical Society of London has been under consideration for some time. It has now been decided to proceed with the amalgamation. Certain alterations are to be made in the articles of association of the Physical Society, and, in due course, a general meeting of the Optical Society will be held to wind up the society.

DISCUSSION

LEIDY'S CRETACEOUS REPTILES OF THE UNITED STATES

IN Professor Henry Fairfield Osborn's interesting biography of Edward Drinker Cope, paleontologist, there appears on page 169 a severe criticism of Joseph Leidy's "Cretaceous Reptile Fossils of the United States, published under the auspices of the Smithsonian Institution," which Cope erroneously attributes to Professor Huxley, taken from the *Geological Magazine of London,* 1868.

The appended correspondence from the letter files of the Smithsonian Institution, contributed through George P. Merrill, geologist in charge, and the letter files of Professor Leidy's personal correspondence, should be preserved in the interest of the history of American science of that period and as a prelude to the *Elasmosaurus platyurus* episode, which is further elaborated on pp. 403–409 of the same biography. It is curious that Cope should have drifted into this error, as the work in question "was referred in 1865 by Secretary Baird of the Smithsonian Institute to Louis Agassiz and Edward D. Cope for review as to publication, both men naturally approved it" (see page 159), and, as Professor Osborn states, this memoir entitled "Cretaceous Reptiles of the United States" collected all the previous knowledge of American explorers, and put into the hands of Marsh and Cope all the knowledge of cretaceous reptiles up to that year, just as Leidy in his subsequent contributions of 1869 reviewed the entire western fossil mammalian life.

JOSEPH LEIDY, II

PHILADELPHIA

1302 Filbert Street,
Philadelphia, Pa.,
February 4, 1869.

COPY

P. S.

Dear Professor Henry:—

A very unfavorable criticism recently appeared in the London Geological Magazine on my last work on the

''Cretaceous Reptiles,'' published by the Smithsonian Institute. The review was signed by ''H,'' which led others and myself, to suppose [that it] proceeded from Huxley, and I assure you I felt much annoyed about it, though I took no printed notice of it. I have just been informed by Professor Newberry of New York, that he was authorized to say that Professor Huxley not only did not write it but knew nothing of it until it was printed and that he does not sympathize with, but utterly condemns it. I give this information to you for I should not like my credit disputed.

Yours truly,
JOSEPH LEIDY.

School of Mines, Columbia College,
Corner 49th Street & 4th Ave.,
New York, Jan. 29th, 1869.

Professor Joseph Leidy
My dear Sir:—

I suppose you have noticed the very harsh and unjust review of your ''Cretaceous Reptiles'' in the October Number of Geological Magazine. I need not assure you that all who know you and the high character of all the scientific work you have done feel that American science which has no more creditable representative than yourself has been grossly insulted in the article referred to and that on this side of the Atlantic at least this review will do you more harm than good.

My object, however, in writing you now is not to tell you this, for you must know that such would be the feeling of your scientific friends, but to say to you that if you have been led to suppose from the fact that this review was signed ''H'' that it was written by Prof. Huxley, as was the impression producing great surprise and regret among us here when it was published, I can have the pleasure of assuring you that Professor Huxley did not write the article and knew nothing of it until it appeared and farther that he has no sympathy with the views or spirit of the article and condemns it as earnestly as we do. I have his authority for saying this much to you.

I suspect the avenues and the facts or assertions of the obnoxious article emanated from a source much nearer home.

We all deeply deplore Cassin's early death. At the last meeting of the Lyceum, resolutions of regret and sympathy were passed which will be communicated to his family.

I hope to be in Philadelphia in a few days and to see you. I have some things to say to you that I can't well put on paper.

Yours very cordially,
J. S. NEWBERRY.

SIGNIFICANCE OF BAER'S LAW

IN discussing my paper published in the issue of SCIENCE for November 13, 1931, Kirk Bryan and Shirley L. Mason[1] state that I "neglected to mention the factor of stream deflection due to the earth's rotation," in my explanation of contrasts, "in the rate at which denudation takes place on the banks of any rills or streams flowing in directions approaching east or west" in southern Ohio and in New Jersey. The impression which I get out of the discussion is that the authors consider that the neglect of this consideration may well invalidate all my observations.

The criticism of Bryan and Mason refutes itself: I called attention to the steepness of northward slopes in valleys having streams flowing east and in valleys having streams flowing west, mentioning both directions specifically. How then would right-hand deflection result in steepening of northward slopes? Their entire criticism breaks down before this one simple fact. It hardly seemed necessary to state that field observations yielded no hint of the influence of rotation on topography, nor to discuss that factor in a brief note on slope asymmetry. However, the point is discussed, and negatively dismissed, in one of the references I cited. F. Bascom[2] explains the steeper nothward slopes, characteristic of the Coastal Plain in New Jersey, on the basis of differential exposure which causes contrasts in the active processes of weathering and transportation.

Bryan and Mason cite the classic example of steep banks on the western sides of Long Island streams as evidence of the potency of rotation in producing asymmetric valley cross-sections. As Fuller[3] limits this characteristic to the portions of these valleys in outwash plains and definitely states that their cutting began in Wisconsin time it seems strange that Bryan and Mason shy away from the study of asymmetry in the glaciated portions of North America on the basis that many of the streams are "too youthful." Their statement that "Obviously the nearly unglaciated northern portion of Asia is the region for testing" the question of valley asymmetry appears inconsistent with their faith in the examples cited from Long Island.

The principle that rivers in the northern hemisphere tend to cut their right banks more vigorously than their left was apparently first advanced by Babinet,[4] though it is customarily called Baer's Law because of its formulation by Karl von Baer[5] in 1866. Dunker, Klockmann, Nansen, A. E. Nordenskiöld and others have discussed it at various times since. American geologists usually refer to the classic papers by Gilbert on the question. In recent years, Eakin[6] has concluded that it is operative for the lower 600 miles of the Yukon and that it influences the pattern of the Missouri River. The deflective force acting on any moving body varies with its mass, its velocity, and the sine of its geographic latitude. The factor of latitude is of such importance that the law has seldom been considered in explaining the courses of streams other than those in comparatively high latitudes. The factors mass and velocity are such that the possibility of an asymmetric effect appears to be reduced to insignificance in the case of smaller streams. Geologists are by no means united in an opinion that even under favorable conditions valleys, thalwegs, streamthreads, or stream patterns demonstrate unquestionably a morphologic effect of earth's rotation. Sir Archibald Geikie[7] states, "When, however, we consider the comparatively small volume, slow motion and continually meandering course of rivers, it may reasonably be doubted whether this *vera causa* can have had much effect generally in modifying the form of river-channels."

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[1] ''Asymmetric Valleys and Climatic Boundaries,'' SCIENCE, 75: 215, 1932.

[2] *U. S. Geol. Surv.*, Folio 167: 2, 1909.

[3] M. L. Fuller, ''Geology of Long Island,'' *Prof. Paper* 82: 51, 1914.

[4] *Comptes Rendus Acad. Sci.*, xl: 638, 1849.

[5] *Bul. Acad. Sci. Petersbourg*, 2: 1, 218, 358, 1866.

With but little effort an array of examples may be marshaled in support of Baer's Law, for example, those considered by Eakin, taken from the course of the Missouri River; or, equally convincing facts may be cited against it. The most rigorous test of the whole hypothesis, in all probability, has been that applied by Exner,[8] who finds that the swift-flowing, relatively large and well-established Danube at Vienna has about one one-thousandth more corrasive effect upon the right half of its bed than upon the left. In the light of Exner's rigorous computation of the deflective force acting on the Danube it seems utterly absurd to invoke the rotation of the earth as an explanation of conspicuous slope asymmetry in valleys of small streams and rills in southern Ohio and in New Jersey, apart from the fact that the phenomena cited in my paper are not limited to right banks.

In a series of observations on the geology and geomorphology of Louisiana now being undertaken by members of the school of geology at this university the thesis advanced in Baer's Law will be closely scrutinized. Though the latitude is somewhat less than that of southern Ohio and New Jersey, adequate compensation should exist in the slight degree of induration of the sediments being cut by streams flowing across the Coastal Plain.

RICHARD JOEL RUSSELL
LOUISIANA STATE UNIVERSITY

LIGHT A FACTOR IN RANCIDITY[1]

RESULTS of experiments conducted in the Food Research Division of the Bureau of Chemistry and Soils show that certain wave-lengths of light play an important rôle in producing rancidity of oil-bearing foods.

Rice bran and rice polish were used in this investigation. When these products were kept under color filters such as blue, purple, blue-green, yellow and various shades of red, they showed characteristics of rancidity when examined organoleptically and by the modified Schiff's test. When kept under sextant green and sextant red filters, however, they showed no evidence of deterioration either by odor or in tests with the fuchsine sulphurous acid reagent. It is evident that the green filter, which approximates chlorophyll green, absorbs all photochemically active wave-lengths conducive to rancidity, allowing only chemically inert wave-lengths to pass through. The sextant red filter, being virtually black, accomplished the same result by absorbing practically all light. Screening out certain wave-lengths of light from oil-bearing foods and feeds, therefore, prevents or delays oxidation of the oil.

Antioxidants, such as pyrogallol, hydroquinone and substituted hydroxylamines, when added to oil-bearing foods may prevent or delay rancidity, but their use is considered objectionable on account of their possible physiological effects.

The keeping qualities of foods, such as salad oils, mayonnaise, butter, lard and potato chips, may be greatly enhanced by the use of properly colored wrappers, bottles, etc., capable of screening out active light wave-lengths.

A U. S. public service patent and foreign patents covering this discovery have been applied for. The application of the principle embodied in these patents should prove of great economic value to producers of package foods.

MAYNE R. COE
BUREAU OF CHEMISTRY AND SOILS,
U. S. DEPARTMENT OF AGRICULTURE

TWISTED TREE TRUNKS ON THE GASPÉ PENINSULA

IN connection with recent discussions in SCIENCE relative to the twisting of tree trunks during growth I should like to call attention to a forested area in Eastern Canada which should prove interesting to any one working on the growth of such trees. While encircling the Gaspé peninsula in the Province of Quebec over the new Perron Boulevard, we observed, among the logs which had been brought down from the mountain forests for pulp wood, a great many which were noticeably twisted, and where the more open agricultural land is divided by rail fences, twisted rails were very common; in fences four rails high, often one out of four and sometimes three out of four would be thus misshapen. As both pulp logs and rails were stripped of bark this twisting is very evident, especially with the latter when they are old and weathered.

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[6] H. M. Eakin, "The Influence of the Earth's Rotation upon the Lateral Erosion of Streams," *Jour. Geol.*, 18: 435–447, 1910.

[7] *Text-Book of Geology, London* (Macmillan and Company, 1: 23, 1903.

[8] Felix M. Exner, "Zur Wirkung der Erddrehung auf Flussläufe," *Geog. Annaler*, 9: 173–180, 1927.

[1] Food Research Division Contribution No. 137.

The Gaspé is easy of access by auto from points in Maine and Quebec and with a guide familiar with the mountain forests this area would not be a difficult place to conduct investigations. A knowledge of French would be a desideratum, for, although the peninsula has been settled for some 300 years, practically all the population still speaks French only.

BEIRNE B. BRUES

SCIENTIFIC BOOKS

The Theory of Groups and Quantum Mechanics. By HERMANN WEYL. Translated from the second (revised) German edition by H. P. Robertson. New York, E. P. Dutton and Company. 422 pp. $6.00.

THE major importance of this authoritative work on group theory and quantum mechanics has become well known to theoretical physicists since the publication of the first German edition almost four years ago. Besides providing the most modern and stimulating account of the theory of groups as a branch of mathematical discipline, Weyl's latest book gives a masterly account of the applications to quantum mechanics. The first edition suffered from an extreme condensation which made it difficult to read. The second edition includes much new material corresponding to the advances particularly in quantum electrodynamics and in the theory of chemical valence. Moreover, the new edition is characterized by considerable improvement in clarity of presentation. This, together with the fact that the work is now available to American readers in an excellent translation, should give a great impetus to the assimilation of these ideas by American physicists.

Since the subject-matter of the book is quite abstruse, the reviewer feels that a technical criticism of its contents is of less value in a journal of general interests such as SCIENCE than a short essay on the general nature of group theory and its rôle in theoretical physics.

What, then, is group theory? A group consists of any set of elements in particular mathematical operations, which possesses a few simple properties. Each element of the group is an operation performed on some object. The single operation, which is equivalent in its effects to the successive performance of two operations of the group, is also counted as an element of the group. The inverse operation or operation that "undoes" the effect of any element of the group is further counted in the group. Two elements that "undo" each other in this way are called reciprocal elements. The identical operator, or the operation which leaves the object unaltered, also must occur in the group. The mode of combination of the elements must also obey the associative law, a simple general requirement which need not be stated explicitly.

It seems astonishing that the deductive method applied to such general postulates could produce a large body of theorems. But this is the fact, as mathematicians know. Of course, although they delight to express their results in the most abstract form possible, they know too that the group concept arose in a much more concrete way than the preceding paragraph would indicate. Perhaps the subject can be traced to Lagrange's (1770) recognition of the relation of the operations of permuting a series of objects to the theory of algebraic equations. But the real development of the subject with the same application in mind began a century ago (1831) in the researches of Galois. He introduced the term "group" in mathematics in the present technical sense of the word.

The details of the theory and the kind of applications depend much on whether the group contains a finite or an infinite number of elements and if infinite, whether the elements constitute a continuous or a discrete aggregate. In elementary geometry finite groups are of interest in studying regular solids: here each element of the group is the operation of rotating the solid through some particular angle about a particular axis so that the solid after rotation is indistinguishable from its aspect before the rotation. Thus a cube may be rotated through 120 degrees about a body diagonal without altering its geometrical relation to other objects. Closely related to this application to regular solids is the use of the theory of finite groups of rotations to describe and classify the various types of crystal symmetry. Considerations of this sort made possible a theoretical crystallography (Schoenflies, 1891) which has come very much to the foreground since Laue's discovery (1912) of the diffraction of x-rays, which provided a laboratory means for finding the arrangement of atoms in crystals.

The theory of infinite groups, especially of continuous groups, that is, groups each element of which is associated with a value or set of values of one or more continuous variables, finds application in the more advanced parts of geometry. The essence of a system of geometry is contained in its means of characterizing the figures or designs that are counted as equivalent. Thus in ordinary geometry a circle and an ellipse are not counted as equivalent figures. But projective geometry counts as belonging to the same species any plane figure and the shadow cast by that figure when interposed between another plane and a point source of light. A circle may cast an elliptical shadow so an ellipse and a circle will be equivalent.[1] Other special systems of geometry are built on other relations of equivalence than that of the optical shadow just mentioned. But the general idea is much the same, as Klein first recognized in 1872 in his famous "Erlanger Programm." Here Klein first showed how the abstract theory of groups could serve as a unifying principle for the treatment of the numerous special advances in geometry made in the earlier part of the century.

This application of group theory to geometry brings us close to another leading concept which is of great importance to modern geometry and theoretical physics: the notion of invariance, and associated ideas like covariance. When a rigid body is displaced we say that its length is unaltered, that is, the length is unaltered or invariant under the operation of displacement. The group of all displacements includes any translation and any rotation. Length is an invariant of the group. When we say that length of an actual physical body is invariant we are making a physical assertion which may or may not be true of real bodies. But any way this may serve as an illustration of the concept of invariance.

Now it is fairly evident that such invariant quantities are the important elements in a physical theory, and thus we see how Klein's "Erlanger Programm" reaches over into physics: the physicist must learn to recognize the invariant elements in situations that confront him, and he must learn the nature of the group of operations under which that element is an invariant.

Klein himself recognized these things, and so we find that a set of his lectures delivered in 1915–1917 on the history of mathematics bears the subtitle, "Die Grundbegriffe der Invariantentheorie und ihr Eindringen in die mathematische Physik."[2] Aside from development of ordinary vector analysis and quaternions which are as much geometry as mathematical physics, the notion of invariant formulation of physical laws first found expression in the theory of relativity.

It is a triviality to say time is a fourth dimension in a world of space-time, if the statement carries no more content than that t is a fourth independent variable to go with x, y and z. What is the extra something which puts content into the concept of space-time? It is the specification of the group of transformations in space-time with which important physical invariants are associated. The crisis which resulted in the theory of relativity may be described thus: mechanics and electrodynamics each could be given invariant formulations, but the two branches of physics, while having common elements, seemed to be associated with different groups.

The group associated with classical mechanics is known as the Galilean group, while that of electrodynamics is the Lorentz group. Experiments like that of Michelson and Morley decided in favor of the Lorentz group as more fundamental for physics, so mechanics had to be altered to fit. In the Lorentz group, length of a rigid body is not an invariant, so the length appears different to different observers —the famous Lorentz-Fitzgerald contraction.

The general theory of relativity is simply a further development of the preceding ideas. For the examples thus far cited, the operations or transformations are linear in the coordinates of the points involved. Let them be general analytic transformations and let invariants of such an extended group be studied and the mathematical substratum of the general theory lies at hand. Of course to make a physical theory these mathematical results need coordination to the world with physical postulates, but the theory of groups provides the basis.

Now at last to quantum theory. In the examples heretofore cited, where the subject-matter is relatively less abstract, the development actually went ahead pretty much without the aid of the theory of groups. After it was completed the group theory provided the most systematic and unified standpoint from which to regard the results. But that was not the case with quantum mechanics. Here the applications of group methods (first by Wigner, then soon afterward by Heisenberg, von Neumann, Weyl and others) actually preceded development in other ways and first gave some of the most important new concrete results of quantum mechanics. The main applicability of group theory to quantum mechanics touches on two invariantive properties of the equations: An atomic system is invariant under ordinary rotations of the coordinate axes, hence the applicability of the continuous group of rotations as in geometrical problems; moreover, the different electrons in a many electron system are dynamically indistinguishable so the finite group whose elements are permutations of the electrons finds use here.

The theory of groups should be thought of as more than a tool for solving special problems, however, and it is in the connection now to be mentioned that the theory probably is most important for quantum theory and for theoretical physics in general. In spite of successes the present laws of quantum physics have their defects, and so it is necessary to find new and better ones. In the search for these, certain broad general requirements are laid down by the restrictions of invariance under different groups. The theoretical physicist need not waste time looking for laws outside the bounds thus set. More positively he finds on looking inside these bounds that the researches of pure mathematicians there have already provided a store of possibilities that await application to physics. This is the line of attack which will probably prove most fruitful in future modifications of the present quantum theory. It is for stimulation in this direction that a study of Weyl's book is perhaps most profitable.

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[1] Actually the relation of projectivity is more general than that of perspectivity, but that does not alter the argument.

[2] Is it permissible to praise one book while reviewing another? This book of Klein's is delightful reading and the most valuable mathematical historical work that I have seen.

To conclude, I can not refrain from giving wider circulation to an interesting historical point connected with the modern theories of chemical valence. In 1878, Sylvester, then professor of mathematics at Johns Hopkins, was worried about a lecture he had promised to give. He writes, "Casting about, as I lay awake in bed one night, to discover some means of conveying an intelligible conception of the objects of modern algebra to a mixed society . . . and impressed as I had long been with a feeling of affinity if not identity of object between the inquiry into compound radicals and the search for "Grundformen" or irreducible invariants, I was agreeably surprised to find, of a sudden, distinctly pictured on my mental retina a chemico-graphical image . . ." He then goes on to expound a very close analogy between his algebraic researches in invariants and the theory of chemical valence. He concludes with the sentence, "Thus we see that chemistry is the counterpart of a province of algebra as probably the whole universe of fact is, or must be, of the universe of thought."

This paper[3] does not seem to have attracted much attention: it was probably too mathematical for the chemists and too chemical for the mathematicians. It is mentioned, however, by Study,[4] in the Encyclopädie der Mathematischen Wissenschaften, who is somewhat inclined to sneer. "Formal analogies to the chemical structural formulas which occur in the theory of invariants of binary (and other) algebraic forms, have given rise to the fantastic hope," he writes, "that chemistry has something to gain from this branch of algebra. M. Noether has rightly, in a report on such attempts, pointed out the superficiality of the whole relationship and the lack of an actual analogy."

But the point of the story is that just exactly Sylvester's analogy and detailed calculations now play a rôle in quantum mechanical theories of valence, as Weyl has shown. The moral is obvious.

Edw. U. Condon

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INEXPENSIVE MICROGRAPHIC PROJECTOR

A projection and drawing apparatus which embodies many desirable features not found in commercial machines can be made after the design in Figs. 1, 2 and 3 accompanying this article.

An ordinary microscope is fastened to a vertical stand and inverted so that the light from a powerful lamp passes through the microscope projecting the image on a table to which the stand is attached.

The support is made of such material as is available to every laboratory. Ordinary ¾ inch galvanized pipes (B) are attached to a 47″ x 10″ x 1¼″ board by means of the collars (B′). The lamp is bolted to the wooden carrier (C) and the microscope is attached to a similar carrier (E) by means of a bolt and a strip of metal (D). Back and top views of a carrier are shown in Fig. 2, to show the location of the grooves which fit around the pipes (B). The carriers are held in place by tightening the bolts with wing nuts. The stand is held in a vertical position by the stove bolts (F) which hold it to the boards (H). These boards are fastened to the table by means of wood screws. The table top is made of white pine.

The microscope should be equipped with a substage condenser and interchangeable oculars of different magnifications. A loose ocular is held in place by inserting a very small piece of paper between it and the draw tube. A Bausch and Lomb light with a six-volt ribbon filament bulb gives very satisfactory illumination.

To operate the microscope and lamp, attach as illustrated. A slide is clamped on the microscope stage in the usual manner. A mechanical stage may be used to good advantage. Next the lamp is adjusted to obtain the maximum illumination. For low power work better illumination is secured when the substage condenser is removed. The image is brought into focus on a sheet of white paper on the table top. The size of the image may be regulated by changing the distance between the microscope (E) and the paper. To absorb the heat from the lamp a water

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[3] Sylvester, "Mathematical Papers," 3, 148.

[4] Encyclopädie, VI, 389.

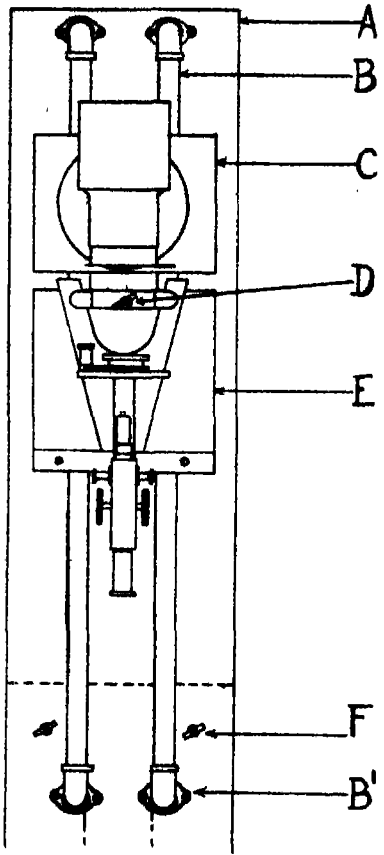

FIG. 1. Showing front view of apparatus.

bath may be interposed between the microscope and lamp.

In addition to projecting images from prepared slides, the apparatus offers numerous other applications. For example, material which must be maintained in a liquid may be placed on a slide or in a petri dish and set on the base of the microscope, after the substage condenser has been removed, and projected with the low power objective. The apparatus can be used to demonstrate to a small class the circulation of the blood in a frog's foot. It can also be made to serve for short distance projection. To accomplish this, the wing nuts (F) are removed and the apparatus is placed on the table in a horizontal position. A camera may be fitted to the microscope for taking photomicrographs.

To my knowledge no commercial drawing apparatus is equipped for projection of large transparent objects, such as long insect wings. To adjust the apparatus for large field projection the same stand as shown in Fig. 3 is used, but a large lens (I) and a portrait lens (J) are substituted for the microscope (E). An image of the object, which is placed on the flat surface of the lens (I), is projected through the lens (J) to the table. The support illustrated was made to accommodate the lens equipment of an old Leitz photomicrographic machine. For the lens (J) a 72 mm Bausch and Lomb-Zeiss Tessar lens as well as other close-range camera lenses were found to give good results.

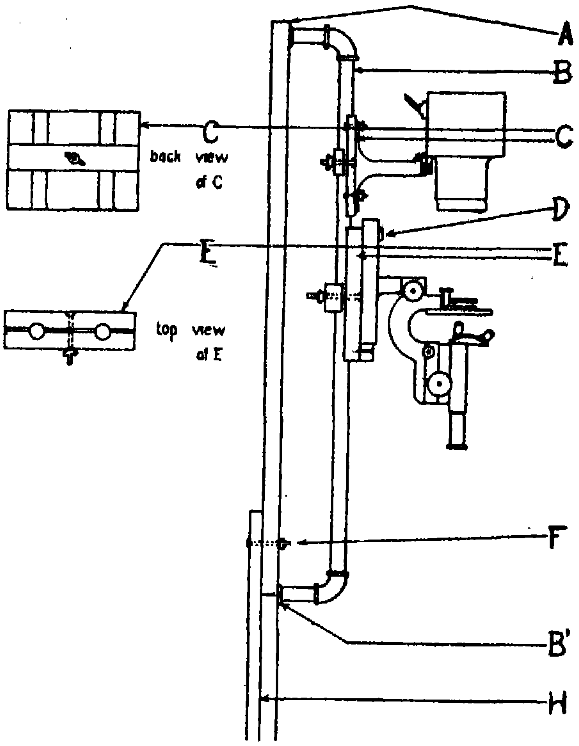

FIG. 2. Showing side view of apparatus.

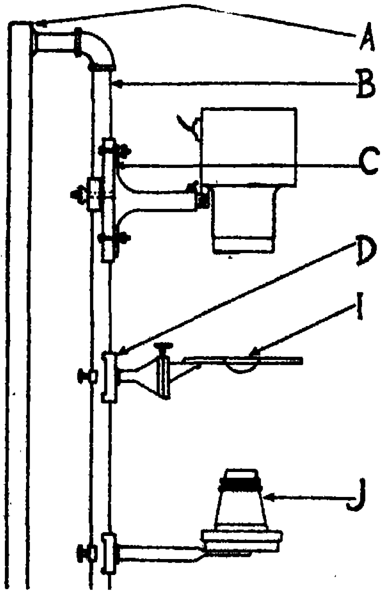

FIG. 3. Showing equipment for large field projection.

In addition to the distinct advantage of projecting images of objects ranging in size from those as large as butterfly wings to objects for which high power objectives must be used, the apparatus has other desirable features. It projects images which are in every respect equal to those of commercial machines. Only the higher priced devices are equipped with nose pieces as found on microscopes. Little time is lost in adjusting the parts of the machine for projection, because its operation is very simple. The cost for materials and labor to construct the support and table was less than eight dollars.

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DEVICE FOR WASHING MICROSCOPICAL TISSUES

Devices for washing microscopical objects are legion. However, there is no method, so far as we know, that is satisfactory from every standpoint. Any device for washing tissue should meet certain requirements. In the first place it should be simple of construction so that the student of microscopy can prepare one in short order from the materials found around the average laboratory. In the second place the apparatus should thoroughly wash the objects, subjecting them to a constant stream of fresh water.

The following method is convenient to construct and has certain other advantages. A wooden block about 12 inches by 6 inches by 1 inch is provided with holes 1 inch in diameter and about ¾ inch deep, spaced at intervals of about 1½ inches, in which vials ⅞ inch in diameter are set. These vials are fitted with 2-holed rubber stoppers which fit tightly. The glass tube D (Fig. 1) is run through one hole nearly to the bottom of the vial. The other tube C projects through the stopper into the vial only a short distance. These are connected in series with rubber hose as shown in Fig. 2. Pieces of cheesecloth are tied over the inner ends of the rubber stoppers so as to cover the ends of the outlet tubes and prevent the objects from washing out. The hose A (Fig 2) is connected to the spigot and the other, B, is the outlet. A steady, gentle stream of water is allowed to flow through the vials for the desired length of time. This device insures thorough washing, for the objects are constantly agitated and revolved by the current of water. The whole apparatus may be placed out of the way at one side of the sink. A varying number of vials may be used according to needs.

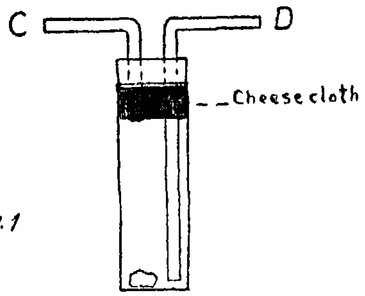

Fig. 1

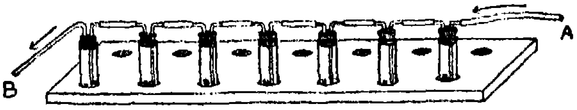

Fig. 2

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SPECIAL ARTICLES

THE EVOLUTION OF A CAROTID SINUS REFLEX AND THE ORIGIN OF VAGAL TONE

Reflex inhibition of heart rate has been observed in elasmobranchs upon mechanical or electrical stimulation of sensory endings distributed widely over the body, both externally and internally, including the gill region and the heart itself.[1] In mammals the sensory areas from which reflex cardiac inhibition may be obtained are limited, the most important being located in the aorta and in the carotid sinus.[2] Since in mammals an alteration of pressure within these blood vessels may be a physiological stimulus, the writers tried the effect of alterations of pressure within the branchial vessels of elasmobranchs.[3]

The ventral aorta of *Squalus acanthias*, with the cord destroyed, was ligated between the first and second branches and a cannula connecting with a burette, containing a physiological solution, was inserted anterior to the ligature. Cardiac inhibition was obtained when the pressure within the gill vessels was suddenly increased. A series of threshold determinations showed that an average increase of 10.7 mm Hg above the average systolic pressure in the dorsal aorta was found to constitute an effective stimulus for the inhibitory response. The response was found to be reflex, with afferent pathways located in the branchial nerves and efferent fibers in the vagus supply to the heart. Determinations of the blood pressure showed the average ventral aortic systolic pressure to be 28.2 mm Hg, the average dorsal aortic systolic pressure to be 15.4 mm Hg, and the average ventral aortic pulse pressure to be 13.3 mm Hg. The reflex cardiac inhibition, following the increased ventral aortic pressure which results from a spontaneous ejection reflex, lowered the ventral aortic diastolic pressure to a significant degree. The mechanism may therefore be considered of physiological significance and may be compared with the carotid sinus mechanism of mammals.

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[1] B. R. Lutz, *Biol. Bull.*, 59: 170, 1930.

[2] J. A. E. Eyster and D. R. Hooker, *Am. Jour. Physiol.*, 21: 373, 1908; G. V. Anrep and H. N. Segall, *Jour. Physiol.*, 61: 215, 1926; C. Heymans, "Le sinus carotidien," Louvain and Paris, 1929.

[3] B. R. Lutz and L. C. Wyman, *Biol. Bull.*, 62: 10, 1932.

When the amphibian *Necturus maculosus* was used, reflex cardiac inhibition resulting from mechanical or electrical stimulation could be obtained only from the gills (Fig. 1). A sudden increase of vascular pressure within the gill vessels also evoked reflex cardiac inhibition, even when the burette pressure was as low as 34 mm Hg.

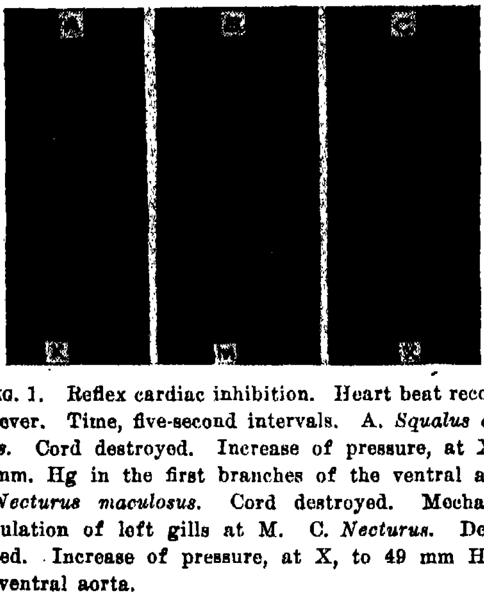

FIG. 1. Reflex cardiac inhibition. Heart beat recorded by lever. Time, five-second intervals. A. *Squalus acanthias.* Cord destroyed. Increase of pressure, at X, to 44 mm. Hg in the first branches of the ventral aorta. B. *Necturus maculosus.* Cord destroyed. Mechanical stimulation of left gills at M. C. *Necturus.* Decerebrated. Increase of pressure, at X, to 49 mm Hg in the ventral aorta.

It is conceivable, therefore, that in the course of evolution the wide-spread sensory areas of the ancestral form, possibly typified by the elasmobranch, with *Necturus* as an intermediate type, were concentrated or restricted until the condition seen in the mammal was reached. Since the carotid arteries of the mammal are derivatives of the primitive branchial system, the reflex cardiac inhibition of branchiovascular origin may exemplify the evolutionary forerunner of the carotid sinus reflex in mammals.

Inasmuch as the threshold for this reflex in *Squalus acanthias* was found to average 10.7 mm Hg above the dorsal aortic systolic pressure, and the average ventral aortic pulse pressure was found to be 13.3 mm Hg it follows that inhibition may occur with each heart beat. For example, in a typical case the ventral aortic systolic pressure was 22 mm Hg, the ventral aortic pulse pressure was 16 mm Hg, and the reflex was elicited when the pressure in the burette was raised to 18.6 mm Hg, a pressure well below the ventral aortic systolic blood pressure. Marked vagal tone of the heart has been found to exist in elasmobranchs.[4] It is suggested, therefore, that this vagal tone is initiated and maintained reflexly through the successive increases in blood pressure in the afferent branchial system due to the heart beats. It may be possible, however, that the vessels of the first two gills, isolated by the experimental procedure from the direct effect of the heart and exposed only to back pressure from the dorsal aorta, have become adapted to a lower pressure and show an abnormally low threshold. We have seen no evidence, however, for this supposition.

In mammals action currents synchronous with the heart beats have been recorded in the afferent vagus and in the cardiac depressor nerve.[5] Bronk[6] found action currents in the cardiac depressor and in the carotid sinus nerve of the rabbit coincident with the rapid rise of pressure in the pulse wave followed by comparative inactivity during diastole. This evidence and that obtained from the dogfish point to a special function of these afferent nerves, stimulated by the systolic pulse, in connection with the reflex origin of vagal tone. The phylogeny of a special physiological process in mammals is thus indicated.

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A LABORATORY EXPERIMENT IN ANIMAL BEHAVIOR

MOST modern courses in elementary biology or zoology include in the laboratory at least one exercise on reactions of living animals to stimuli such as light, gravity, touch, chemicals, etc. The animals which have been most frequently used in our own laboratories are Eisenia, Tenebrio larvae and Drosophila. Light responses of Eisenia and Tenebrio larvae are not easily studied in the laboratory which does not have suitable darkrooms available. This year we tried with considerable success a study of the responses of an animal which reacts readily to light under laboratory conditions.

Many fresh-water mussels are infested with parasitic water mites which live between the gills. One of the common species of the eastern United States, *Unionicola ypsilophorus* var. *haldemani* (Piers), is found in *Anodonta cataracta* Say. This mite occurs abundantly, at least in eastern Massachusetts, and can be obtained at any time of year when the host is available. When these animals are removed from the host, washed and placed in water free from host material, they show a positive response to light. If water from the mantle cavity, or water extract of the gills is added to water containing the mites, they usually show a distinct reversal to a negative state as regards the light. This negative response may persist for a half hour or more if the concentration of host material is high. The reversal may be interpreted as a type of conditioned response brought about by some material from the host; the positive response to light being primitive and the negative response acquired since the mites have taken up a parasitic life. It may also be shown in the case of *Unionicola* from *Anodonta* that only material from the host will bring about a reversal, water from the mantle cavity or extract of the gills of such forms as *Elliptio* or *Lampsilis* having no effect on the mites. The influence of host on parasite is seen therefore to be specific for a particular host-parasite combination.

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[4] B. R. Lutz, *Biol. Bull.*, 59: 211, 1930.

[5] W. Einthoven, *Quart. Jour. Exp. Physiol.*, 1: 243, 1908; E. D. Adrian, *Jour. Physiol.*, 61: 49, 1926.

[6] D. W. Bronk, *Proc. Soc. Exp. Biol. Med.*, 28: 1014, 1931.

In a typical experiment ten mites are placed in a small rectangular glass jar with sufficient water to cover them. This is placed between two light sources which may be used alternately. In a series of trials, using first one light source and then the other, the number of mites which are positive may be determined and any which are negative may be removed if desired. If one light source is of high intensity (100 watt lamp) and one of low (15–25 watt lamp) they may both be used at the same time and the effect of intensity on the behavior of the mites observed.

Next, using one light source and attracting the animals to the end of the jar toward the light, a small amount (1–3 cc) of filtered extract of gill may be added in the neighborhood of the mites, and usually there is an immediate reversal to a negative state. This is not a chemotropic response, for the mites will often move out of the region of greatest concentration of extract to a region of lower concentration. If results are not conclusive the mites may be washed, returned to fresh water, and the experiment repeated.

Finally, if desired, the mites may be allowed to collect on a small piece of gill and usually, regardless of directional illumination, they will remain on the piece of gill probably as the result of a positive stereotropic response to a familiar surface.

Not all species of mites are satisfactory for such experiments. Some have been parasites for so long that they have lost almost all power of locomotion, others, such as *Unionicola fossulata* (Koen) from *Cyclonais tuberculata*, are positive only to light of low intensity (about 0.1 meter candles) a condition difficult to attain outside the darkroom.

Two papers by the author regarding the behavior of parasitic water mites have appeared elsewhere.[1]

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ZOOLOGICAL LABORATORIES,
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THE NATIONAL ACADEMY OF SCIENCES. III

Experiments on the nature of the structural units of solids: ALEXANDER GOETZ (by invitation). It is necessary for a general understanding of the physical properties of crystalline solids to assume in addition to a regular geometric configuration of atoms or molecules in a crystal lattice also the existence of a mosaic structure, as has been proposed in recent years by Smekal, Ewald, Darwin and Zwicky mostly with regard to heteropolar substances. Because of the special interest of the effects depending on the mosaic structure in metals, *i.e.*, homopolar lattices, a systematic experimental investigation has been started which, up to the present, leads to the following general conclusion: A crystal consists of a more or less regular conglomerate of structural units, the size of which is a quality of the substance in question. Each unit is an ideal crystal in itself, its boundaries which coincide with certain low index planes form potential walls, which as such affect the electric transparency of the crystal. Impurities of structurally different substances are imbedded within the boundaries affecting their separating qualities and being sometimes even able to start new types of boundary-layers along different crystallographic planes. At higher temperatures the perturbing influence of these boundaries affects the structural unit to a larger extent and thus decreases the size of the ideal structural unit without affecting their number. Hence a block of metal in its most stable, *i.e.*, single crystalline configuration is considered as consisting of a crystalline and an amorphous component.

Supra-conductivity and the Hall effect: EDWIN H. HALL. Kamerlingh Onnes described two experimental investigations, each of which he regarded as indicating that there is no Hall effect in the supra-conductive state of a metal. In the first of these, plates of tin and of lead, respectively, in the supra-conductive state were tested directly for a Hall effect in the usual way, between the poles of a magnet. In the second, a spherical shell of lead, in which self-persistent electric currents had been induced, was suspended in a magnetic field under such conditions that a torque exerted by the twisted suspension was opposed by a torque exerted on the current-bearing sphere by the magnetic field. When a balance between these torques was once established it remained substantially unaffected for hours. Onnes interpreted this fact as proving that the persistent currents in or on the surface of the sphere were held unchanged in their paths in spite of the couple exerted upon them by the magnetic field in which the sphere was suspended, and this conclusion he expressed by saying that there was no Hall effect in the supra-conductive lead. The first of these two methods of experimentation seems open to the objection that the lines of induction of an applied magnetic field can not penetrate a metal which is already in the supra-connective state. Criticism of the second method can not be so briefly stated. The question whether a metal in the supra-conductive state can show a Hall effect remains undecided. The proper way to answer this question would seem to be as follows: Apply the magnetic field to the metal plate, carrying a longitudinal current, while the metal is in the normal state, then cool it to the supra-conductive state, test for a transverse potential difference, then raise the temperature of the metal above the transition point, reverse the magnetic field, cool to the supra-conductive state again, then test for a transverse potential difference opposite to the one observed before.

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[1] "Reversal of Phototropism in a Parasitic Water Mite," *Biol. Bull.* 59, 165, 1930; "Specific Influence of the Host on the Light Responses of Parasitic Water Mites," *Biol. Bull.*, 61, 497, 1931.

The scattering of light by supersonic waves: P. DEBYE and F. SEARS.

The projection of motion pictures in relief: an experimental realization: HERBERT E. IVES (introduced by F. B. Jewett). The projection of motion pictures in relief, visible to a group of observers occupying a wide range of positions with respect to the screen, but demanding no special spectacles or other apparatus at the eyes, has been experimentally realized on a small and crude scale by an application of the principle of the parallax panoramagram. The individual pictures constituting the record of motion and relief are made up of narrow juxtaposed strip images, each of which is a minute linear panorama of the scene presented to the camera. The camera consists of a large 4-foot diameter concave mirror, at whose focus is a transparent screen consisting of approximately 200 minute concave grooves. The virtual images of the mirror formed in these grooves are photographed by a single exposure onto a lantern slide size plate. Prints from negatives so made are then mounted on a large disc capable of slow rotation in the slide plane of a projection lantern coupled with another rapidly rotating disc with an aperture which flashes a bright beam of light through the projection system as each picture comes into position (Plateau's magic disc or Plenakistoscope). The projection screen consists of 200 transparent rods, one quarter inch in width, having convex cylindrical surfaces in front and rear, of such curvatures that linear images on the rear surfaces are projected as parallel beams into the observing space. When the pictures, made as above described, are projected with each panoramic strip in accurate register upon a rod a composite picture is seen on the 4-foot diameter screen which varies with the direction and distance of observation, exhibiting stereoscopic relief. Succession of such pictures at the rate of 15 to 20 per second provides motion pictures in relief. Successful results depend upon such extreme accuracy of all mechanical and optical parts and adjustments that commercial application appears remote.

Some recent developments of electric waves guided by wires: GEORGE O. SQUIER. There is no depression in science, but on the contrary it has been said that we are in the midst of a second and greater Renaissance. During 1931 the Bell Laboratories have concentrated on the investigation of wide-frequency band transmission of electric waves over telephone cable circuits, the results of which are summarized as follows: It now seems clear that circuits can be provided in aerial or underground cable that will have characteristics permitting an extremely wide band of frequencies to be transmitted with substantial uniformity throughout the band. The net result of this work has been to open up the possibility of very long circuits, each of which can carry a very large number of non-interfering telephone communications, and a very much larger number of non-interfering telegraph communications. Television, which is still "around the corner," logically fits into the spectrum of short electric waves guided by wires. The year 1931 has witnessed no "depression" in the development of broadcasting. Instead the thoughts of the whole world were delivered by engineering skill from any quarter to the very walls of the steel frameworks of the huge buildings which house our city populations. This "Outdoor Broadcasting" has been accomplished, but we must now attack seriously the engineering problem of "Indoor Broadcasting" by which these myriad messages may be sorted out and delivered to the vast audiences within these steel walls who are the "supreme court" of ultimate success. The next two years will witness this basic engineering problem being realized by going directly back to the original plans of Marconi. Instead of broadcasting through space for hundreds of miles from an antenna, we will set up a complete radio broadcasting plant inside a multiple wire cable and broadcast multiple programs from a single antenna within the cable to receivers in each of the rooms. This is the only engineering solution of interference prevention to meet the severe requirements of each and every tenant who has chosen to live inside these modern steel structures. There are two methods of accomplishing this, to wit: (1) Utilize the existing telephone plant already provided. (2) Construct a separate wire-wireless indoor broadcasting equipment. Radio City offers an ideal opportunity for this development.

Evidences of cycles in tree ring records (illustrated): A. E. DOUGLAS (by invitation).

Periodicities in solar variation: C. G. Abbot. Summary was made of the observations of the Smithsonian Astrophysical Observatory since 1895, including references to various new instruments for scientific work. Among them is the periodometer which has been employed to discover and evaluate periodicities in solar variation and in the temperatures of Clanton, Alabama, Washington, D. C., and Williston, North Dakota. The variation of the sun since 1918 is well represented as the sum of 7 periodicities, respectively of 7, 8, 11, 21, 25, 45 and 68 months. The temperature departures of the 3 stations named are also closely represented as the sum of these periodicities supplemented by two or three others which seem to be of terrestrial rather than of solar origin. However, at each station the sum of the amplitudes of the periodicities apparently of solar origin exceeds by about twofold the sum of the amplitudes of the terrestrial periodicities. This indicates that temperature departures are largely governed by variations of the sun, and holds out a hope of long period forecasts possibly extending for several years in advance. Further investigation must ensue before this hope can be thoroughly tested.

The nature of the solar cycle: W. S. Adams and S. B. Nicholson. The physical appearance of the sun varies from day to day as the sunspots, faculae and prominences develop and disappear on its surface. These phenomena may be distributed irregularly around the sun so that the number of objects visible at any time depends on the rotation period of the sun which approximates to a month. Their average monthly frequency, therefore, is an indication of the actual solar activity. The solar activity measured by this method fluctuates irregularly in cycles ranging from six to fifteen months and shows variations up to one fourth its mean value. The solar cycle which is most nearly periodic and which has the largest amplitude is of about eleven years' duration. This period may vary between nine and fourteen years and the amplitude of the cycle by about 50 per cent. of its average value. Period and amplitude are apparently unrelated. It seems probable that both the quantity and quality of solar radiation vary during this cycle and many attempts have been made to correlate terrestrial phenomena with sun-spots. Definite correlations have been found with the variations of terrestrial magnetism and its related phenomena. There is evidence of a slight correlation between sun-spots and atmospheric temperature in certain regions on the earth and with other factors of weather and climate for limited regions and for limited time intervals. These correlations are so uncertain that, in the majority of cases at least, predictions based on them have very little weight.

Correlation of sedimentary and climatic records: Isaiah Bowman. The earliest studies of banded sediments were made to obtain measures of geologic time—measures akin to those of Michelson on the speed of light in that the end in view was a more accurate yardstick. Later on, the interpretation of sediments passed into a more advanced stage in which there was accomplished the cross-dating of banded clays of late glacial origin. The most noteworthy work upon them was done by De Geer in Sweden and by Antevs in New England. The latter demonstrated a rate of retreat of the ice in the Connecticut Valley of about a mile in twenty-two years over a period several thousands of years long. By comparing the lake deposits in series along the edge of the ice front the measured rate of retreat of the ice was determined. But up to the present all such datings are relative. That is to say, no one has yet found the bottom of the oldest deposit nor the top of the youngest. Nor has there been established a correlation between the banded clays of New England and the oldest trees. The clays are on one side of the country and the oldest trees, the Sequoias, are on the opposite side and the differences in climatic habit are wide. Because the lakes of the Great Basin have expanded and contracted in response to climatic change, one naturally turns to that region for a possible correlation between lake history and tree history to see if identical periods of wetness and dryness can be distinguished. Unfortunately, from this standpoint, the lakes of the Great Basin are and have been mostly salt lakes, whereas the banded clays that lend themselves most readily to the dating of events in geological time are formed in fresh-water lakes. A neglected field of study has been the sedimentation process. Until that process is studied in detail and correlated with rainfall, temperature, cloudiness and stream discharge, there is no solid experimental basis for the interpretation of sediments now exposed on basin floors in sections that are accessible. The drought of the past three years has exposed lake floors that have been covered with water for many decades and that have been exposed to view probably not more than once or twice since white occupation of the West. This makes it a matter of urgent importance that the studies of the now dry lake beds should be pushed with all speed before they again become covered with water and the sedimentary record of their fluctuations is again difficult to sample.

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SCIENCE

VOL. 75 FRIDAY, JUNE 10, 1932 No. 1954

The Development of Scientific Research in the South: GEORGE J. FERTIG 595

The Early Days of the American Physiological Society: DR. HENRY H. DONALDSON 599

Scientific Events:
The Seventy-fifth Anniversary of the Old South Kensington Museum; Smithsonian Expeditions; Geology, Physiography and Ecology at the Pullman Meeting of the Pacific Division of the American Association for the Advancement of Science; The School of Engineering of Yale University 601

Scientific Notes and News 603

Discussion:
Solar and Radio Periodicities: DR. C. G. ABBOT. *Reports of the Princeton University Expeditions to Patagonia, 1896–1899:* PROFESSOR W. B. SCOTT. *Pleistocene Man in Minnesota:* DR. ALBERT ERNEST JENKS. *The Literature of Taxonomy:* DR. CARROLL LANE FENTON and MILDRED ADAMS FENTON. *An Appeal to American Biochemists:* PROFESSOR RUSSELL H. CHITTENDEN, DR. PHOEBUS A. LEVENE and PROFESSOR LAFAYETTE B. MENDEL 607

Conference on Astrophotographic Problems 609

The American Association for the Advancement of Science:
Business Proceedings of the Executive Committee: DR. CHARLES F. ROOS 611

Scientific Apparatus and Laboratory Methods:
A Short Method for Calculating Moisture Percentages: NELSON MCKAIG, JR. *A Balance for Live Animals:* BRUCE F. CROCKER and PROFESSOR HARDOLPH WASTENEYS 612

Special Articles:
The Chemical Study of Insulin: DR. H. JENSEN 614

Science News 10

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THE DEVELOPMENT OF SCIENTIFIC RESEARCH IN THE SOUTH[1]

By GEORGE J. FERTIG

ALABAMA ACADEMY OF SCIENCE, BIRMINGHAM, ALABAMA

FROM the very start of colonization on the Virginia Coast at Jamestown in 1609 and from even the occasion of the explorations of DeSoto in 1539 or La Salle in 1687, the fundamental bases underlying the settlement of the South in its various areas have been precisely different from those responsible for the colonization of New England, the settlement of the Middle West or the migration to and the building up of the far western sections of the United States.

We begin this treatise on the "Development of Scientific Research in the South" with such a statement because of the belief that a study of the historical background of the South in contrast to the historical backgrounds of other sections of the country is entirely essential to an understanding and appreciation of the trend of the South toward the solution of its numerous problems through the application of science. To discuss such a subject as research development requires previously a knowledge of educational conditions, of political influences and of industrial tendencies, since conditions in the South as regards these aspects were precisely unique.

In reality the South should not be considered as a homogenous unit inasmuch as the manifold reasons for colonization and growth of its many subdivisions were wisely diverse. The individual states came into being under considerably variant circumstances, their educational institutions under equally different influences, but withal it may be said that whatever the original manner of territorial settlement, growth or advancement the Civil War served as perhaps the most powerful factor to effect homogenizing of political thought, educational progress and industrial activity.

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[1] The address of the retiring president of the Alabama Academy of Science, Birmingham, Alabama, March 11, 1932.

The ante-bellum South had no system of public schools such as that of New England or of the more recently settled sections of the country. Its first public-school system began in the days of the reconstruction, although certain of the Southern states had provided earlier in their administration for public instruction. More often the sons of the more wealthy planters, after being provided with a very moderate amount of training, returned to administer plantation affairs instead of continuing their training through academies or Northern colleges.

While the higher institutions of learning in the South were with some exception established through periods comparable to those during which the corresponding institutions in the North were begun, the progress made in their development was many times retarded. Student attendance and financial support retarded the foundation of chairs in the sciences. Training in scientific subjects in particular was put off—even if regarded with favor—in preference to subjects which might be taught without costly equipment or special facilities.

Washington and Lee organized in 1749, the University of Georgia in 1785, Washington and Jefferson in 1787, the University of Tennessee in 1794, the University of Virginia in 1819, the University of Alabama in 1831, Tulane University in 1834, Duke University in 1838, Louisiana State in 1860, the University of Kentucky in 1865, Alabama Polytechnic Institute in 1872, Vanderbilt University in 1873, Georgia School of Technology in 1888 and the University of Florida, organized in 1905, were much slower in development of the sciences than were Harvard University, established in 1636, Yale in 1701, Columbia University in 1754 or Massachusetts Institute of Technology in 1861. There were many reasons to account for the substantial difference in progress of Southern colleges as compared to Northern colleges. Some of these may be traced to the different degree of development of the communities, to financial difficulties, to difference in states of industrial attainment and to precisely different pursuits followed by the inhabitants of the respective territories.

Whatever be the reasons for the slowness in the development of scientific departments in educational institutions they had a telling effect upon the rapidity with which science was applied to the advancement of industry. To be sure, the political problems with which the South was faced during and after the reconstruction were many. The first trend after the war was to return to agricultural pursuits, but gradually movements developed toward greater and greater utilization of the various Southern natural resources. Manufactures increased, using raw materials throughout the South, and with the advent of manifold processes came the demand for further knowledge for the improvement of products, for the establishment of new products and for the study of new methods of manufacture on the part of industry. These demands of industrial progress made distinct requests for assistance from chemistry, physics, medicine, geology, mining engineering, electrical engineering and chemical engineering. All these factors had important influences upon the general attitude of the inhabitants of the Southern states in regard to education and particularly toward higher education and the opportunities which it afforded in industrial endeavors.

Research, in the sense in which we use the word to-day, does not find a place until a status of higher education has been made possible. Scientific research in particular, hardly without exception, demands the expenditure of considerable money. The services of scientifically educated individuals are required. To provide these requirements took the South many years, even after the advances of the sciences of medicine, chemistry, mechanics and allied fields were sufficient and available to human knowledge in this country. It was necessary to send her prospective educators to the Northern states or abroad for graduate work and to augment her faculties of higher institutions with men native to the North.

It was necessary to provide facilities for the basic training of its students in the sciences. Considerably long periods have been required for her educational institutions to assemble funds for the customarily expensive equipment for research. Time was demanded also to grant vision as to the problems to be solved. To-day there is being conducted a great deal of scientific research in the South in educational institutions. Three hundred and seventy-six researches are under way at thirty-one of the larger colleges. It is by far at these larger centers that the predominance of investigations exists, since forty-six of the smaller schools have but thirty-one problems in progress of solution. Thirty-five of the Southern educational institutions have no scientific researches at all under consideration, although it is much in evidence that many of these institutions are paying a considerable amount of attention to technical investigations, though lack of enthusiasm or encouragement, lack of buildings or equipment and lack of library facilities handicap the efforts made.

The South is blessed beyond any other section of the country by its temperate climate, its abundant rainfall, its many raw materials of industry and its excellent facilities for all varieties of transportation of industrial products to the wide world. During the last thirty years increasing attention has been paid to development of raw materials into finished products of much value. Although starting the race of industrial development much later than the other sections of the country in the last years, the South has produced 12 per cent. of the value of manufactured products of the United States, 22 per cent. of the value of mineral products and 28 per cent. of the value of agricultural products.

To say that scientific research did not have an important part to play in this remarkable recovery and sterling advance to a status of industrial prominence would be to omit paying homage to a powerful and effective servant. The recent development of the sciences in the South has not been confined to the mere transplanting of chemical or other scientific processes developed elsewhere to this virgin industrial soil. New things have been accomplished, examples of which are to be found in the naval stores industry, the electrochemical field, the agricultural field, the progress made in the utilization of various clays, blast-furnace slag and minerals, the advances made in paper manufacture from long-leaf pine, the utilization of by-products of the cane-sugar industry, the utility of by-products of the cottonseed and the endeavors that have been made in applying science to natural gas and petroleum. No better way of emphasizing the importance of some of these attainments could be adopted than to permit a few scattered examples of research accomplishment in industrial fields to speak for themselves.

RAYON

Rayon is a radically new textile material, having chemical and physical characteristics entirely different from silk or cotton. Natural silk is an animal fiber produced by certain worms and some spiders. The process of fiber development is long and tedious and consumptive of much material. Worms consuming one ton of mulberry leaves produce only twelve pounds of silk fiber. To produce an "artificial silk" having near strength, beauty and softness of the real silk induced scientists to search into fields offering satisfactory forms of cellulose. To the chemist, cellulose, whether obtained from cotton or wood, is an alcohol similar in type to glycerine. If we treat cotton with nitric and sulfuric acids we obtain cellulose nitrate. This cellulose nitrate, when dissolved in suitable solvents, produces a solution which can be forced through a metal or glass die containing a number of fine holes. On removing the solvent, fine, thread-like filaments are produced. If next the nitric acid radical is removed cellulose in the forms of fine filaments follows. These filaments can be twisted together to form rayon thread. Acetic acid may be substituted for nitric acid to produce by still another process a cellulose acetate rayon which differs from the nitrate rayon by being inflammable. A third method, the cupra-ammonium process, produces cellulose threads by a still different procedure.

At the present time approximately 33,000 tons of cotton linters is consumed by the combined rayon industries of the South, as well as approximately 65,000 tons of sulfite wood pulp, 145,000 tons of 50° Be sulfuric acid and 105,000 tons of caustic soda. All necessary materials are produced in close proximity to the rayon plants. Over one half of the rayon made in the United States is manufactured in the South, specifically in Tennessee, Virginia, North Carolina and Georgia.

PAPER

The paper industry in the South can be traced back to 1744, when a plant existed in Virginia. North Carolina had a mill at Salem in 1766. South Carolina, Tennessee and Kentucky were locations of paper-making establishments about the same time. These small establishments, however, used only certain small amounts of hard woods.

Within the last ten years research developments have shown it possible that a very satisfactory kraft paper may be made from the very widely distributed long-leaf Southern pine. Within this period operations were developed which lead the way to approximately 13 per cent. of the consumption of pulp wood in the country being produced in the South yearly. Kraft paper is made in great quantity in Florida, Louisiana and Alabama for bagging, wrapping papers and many miscellaneous uses. The heavy brown, resinous character of this pinewood pulp renders it unfit for the manufacture of white newsprint. Methods are now in process of trial which are expected to bleach out the undesirable color, and it may be that we soon may expect to read our daily Southern newspapers printed on bleached pulp from the Southern long-leaf pine. Not only does the low cost of these long-leaf pine pulps present an attractive possibility for Southern industry, but considering the fact that rapid all-year growth permits reforestation to continue at a rate more rapid than wood consumption demands, a continuous cycle of production of raw material in excess of requirements is insured. Permanent industrial operation may follow dependent only upon demand for finished product.

COTTONSEED

The cotton crop of the United States for 1928, expressed in units of 500 pound gross weight, amounted to 14,477,000 bales, the total cottonseed produced being 6,435,000 tons. Twenty years ago this enormous tonnage of seed would have been largely discarded, but in 1928, 5,061,000 tons of cottonseed were put through refining processes which produced materials worth $200,000,000.

Research discovered that the lowly cottonseed may be split up into three components—linters, hulls and inner kernels. From the linters processes have been developed for manufacturing rayon, absorbent cotton, twine, rope, artificial leather, lacquers, celluloid, photographic films, varnishes, pyroxylin, carpets, writing paper, artificial felts, guncotton and other similar products.

From the hulls of the cotton seed are produced cattle feeds, paper in a variety of forms, stuffing material for upholstery, adhesives, fertilizer, potash, xylose and numerous other analogous materials.

From the kernels or "meats" of the seed, products are now available which we now see and consume as though they were always existent. Salad oils, lard compounds, emulsions for medical purposes, cosmetics, soaps, cattle feeds, flour for bread, cake and crackers, sardine packing oils, stearic acid for candles, washing powders, roofing tars, insulating materials, cotton rubber and compositions for phonograph records. To these many products industrial research workers are adding new and more spectacular achievements each day. Only recently we are advised by authorities that there is protein enough in a 16,000,000 bale cotton crop to furnish all the protein food requirements for 53,000,000 people for a year.

FERTILIZERS

In the field of fertilizers the South with the aid of research now enjoys a peculiarly enviable position, for the abundant supply of a great variety of materials are applicable to fertilizer manufacture. As an agricultural territory it is important that there is to be found large quantities of by-product sulfuric acid, phosphate deposits, a nitrogen fixation industry, considerable potash resources and raw materials for the manufacture of organic ammoniates.

Research has presented the South with an abundant supply of phosphoric acid and phosphoric acid salts. Even the Southern steel industry has deviated sufficiently from its primary purpose to supply in its basic open hearth slag a material of high phosphate availability to plant life. Nitrogen fixation plants in Virginia have joined hands with coke oven ammonia to supply large quantities of combined nitrogen. For potash to be obtained within the boundaries of the South here exist the possibilities of extraction of Georgia shales, recovery from certain industrial wastes or isolation as a by-product of cane molasses.

Within recent months we have been advised of another attainment of industrial research—the production of a fertilizer of 68 per cent. richness in plant foods—which commercial production was accomplished through the successful chemical engineering feat of the coprecipitation of the three constituents, phosphates, potash and nitrates in one homogeneous, granular product.

Scientific investigations have revealed the chemical characters of many of the Southern soils, and from these investigations steps have been taken to provide the lacking elements. Certain notable researches were performed in connection with soils found to be lacking in lime and magnesia and with the soils of the Florida Everglades which were found to be markedly benefited by additions of copper salts. Mention has already been made of the use of by-products of the cottonseed as fertilizing material.

NAVAL STORES

Approximately 300,000 people in the South are dependent upon the production of rosin, turpentine, pine oil, tar and pitches from the pine tree. Attributable to many varied researches the by-products of the Southern pine are now finding their way into such finished materials as soap, varnish, paper size, printing inks, linoleum, insulation materials and synthetic camphor. The raw products themselves have a market value of $70,000,000 annually. Yet the possible utilities of these raw materials of the Southern pine forests are but slightly developed.

TUNG OIL

For years China has exported annually 100,000,000 pounds of tung oil into the United States for use in the paint and varnish industry. This oil is produced by tung oil trees, whose dried and hulled nuts are crushed to yield a neutral oil. From investigations of soils and climate in sections of Florida as to suitability for growth of tung oil trees, satisfactory conditions were found, and to-day over 560,000 trees are producing tung oil of satisfactory quality. Some 5,500 acres of land is thus being profitably utilized in the cultivation of trees whose fruits are yielding relatively high oil content. An American tung oil industry is thus in its infancy.

BLAST-FURNACE SLAG

The blast-furnaces of Alabama, located principally in the Birmingham district, produce pig iron at the rate of 2,700,000 tons annually, a large percentage of which is basic iron, which is later made into steel. The iron ores of Alabama, which are smelted to produce the pig iron, are not as concentrated as are the ores of Northern furnaces and hence there is produced approximately 1,800 pounds of slag for each long ton of pig iron made. Some 2,300,000 tons of blast-furnace slag, therefore, are available from the furnaces of the district annually. Fifteen years ago this slag was cast off as a waste material, but to-day a large portion of this tonnage is converted to profitable use either as a basis for slag cement or as aggregates for cement or bituminous concrete.

The only blast-furnace slag cements of the country are being made at this time in the Birmingham district. These puzzolan products utilize not only the water-granulated slag of the blast-furnace but hydrated lime from the lime industry of the South.

Slag from the blast-furnaces is cooled in huge graded pits, mined, crushed and graded for use as aggregates. Five hundred miles of Southern roadways are made of Alabama slag and Portland cement. Forty-five hundred miles of Southern roadways are constructed of Alabama slag and bituminous binders. Numerous buildings are made of slag concrete. Practical and scientific research both in the South and North have converted this once undesirable material from a waste to a useful raw material.

These are but a few of the prominent instances where scientific research has aided in the industrial development of the South. To these may have been added mention of many interesting discoveries in the fields of cotton textiles, cotton dyeing, tobaccos, cultivation and preservation of fruits, ceramics, soils, insecticides, petroleum refining, the production of diphenyl, production of helium, the manufacture of aluminium oxide, the production of celotex, the recovery of xylose and many other investigations pertinent to the industrial field.

For the most part these advancements have been largely responsible for industrial chemical research. In the solution of these problems industrial chemistry has been prominently aided and encouraged by geological researches and developments in chemical, electrical and mechanical engineering, so that the sum total accomplishments have not in many cases been attributable solely to the application of any one of the sciences.

To speak of accomplishments of research in the field of industrial development without enumerating some of the important scientific findings contributed from sources usually recognized as being independent of industrial activity would be to neglect paying tribute to many fine attainments.

We were permitted the pleasure one year ago of listening to an accurate account of the South's contribution to the sciences of botany, zoology, medicine, anatomy, surgery, pharmacology, pathology and several other of the sciences. In each of these fields distinct offerings have been made by Southerners. Investigations on the mechanism of heredity, on twins and twinning, oyster culture and mussels, coral formations, absorption spectra of solutions, viscosities of solvents, muscular discoveries, nervous system investigations, the transmission and control of yellow fever, surgical anesthesia, physiological behavior of poisonous alkaloids, ptomaines and cellular toxins and certain researches in connection with epilepsy and its relation to pellagra—these and many other important investigations have been contributed by Southern workers.

In the field of physical research we have to acclaim the attainment in connection with the recent discovery of two of the hitherto undetected members of the much discussed chemical family elements. Through the development of a magneto-optic method of chemical analysis exceptionally fine traces of elements have been made possible of identification and measurement, in concentration even as small as one part in 10^{11}. While academic interest in this accomplishment has centered considerably upon the discovery of the elements "Alabamium" and "Virginium" much promise is to be attached to this magneto-optic method of analysis as an effective tool of quantitative estimation.

To mention, however briefly, the many problems, industrial and academic, which are undergoing scientific investigation in the South at the present time, would be impossible. Likewise to set out the various influences which have stimulated the wide application of technical research in its various forms would be considerably complicated. Suffice it to state that the agricultural and industrial South has not only profited greatly by the relatively small number of contributions it has made to scientific discovery, but it stands to reap much greater benefits from its research conquests of the future. May the splendid accomplishments of the last fifty years serve as an ever accelerating stimulus to finer academic and industrial attainments to the end that in all the fields of science she may currently come to contribute her proportionate share of fruits of scientific research.

THE EARLY DAYS OF THE AMERICAN PHYSIOLOGICAL SOCIETY[1]

By Dr. HENRY H. DONALDSON

WISTAR INSTITUTE OF ANATOMY

As a survivor of the prehistoric period of physiology in the United States, I am asked to speak on the early days of the Physiological Society. Like all such survivors, I find myself in the position of the lady who, after the surgeons had finished with her, reported that she had only lungs and reminiscences left. But in my own case even the reminiscences are fragmentary. Our chairman should have given me notice of this event some 45 years ago, so that I might have been better prepared. Let me sketch the background.

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[1] Address at the dinner of the Federation of Societies for Experimental Biology, Philadelphia, April 29, 1932.

In the eighties the teaching of medicine, with which physiology was mainly associated, was poorly developed. I entered the College of Physicians and Surgeons in New York in 1880. It was then a proprietary school. You paid your fee and were enrolled. You could get your degree in two years by attending endless lectures and taking quizzes with a preceptor. There was a dissecting room—but no laboratories. Dalton held the chair of physiology. He was lucid in his presentation, largely based on French work—for he had been trained in Paris. An exposed heart is the only demonstration I recall.

But something unusual did happen that year. Prudden, who had been abroad with Welch, returned and offered a course in histology. It was given in a deserted ice-cream saloon, during the lunch hour, and with microscopes—mostly French models—which Prudden had borrowed from his friends. There half a dozen of us had a most inspiring introduction to histology. It was the one bright spot in the year.

In 1881 I went to Baltimore to be with Martin, the young professor of biology at the Johns Hopkins University. At that time there were no special societies dealing with biology in any of its aspects—but in 1884 Sam Clarke, then at Williams—and who had been with Brooks in Baltimore—decided that he must have some means for contact with his colleagues. So at his instigation the American Society of Naturalists was formed. In a measure this was a protest against conditions existing in the natural history section of the American Association for the Advancement of Science. This section was over-diluted with non-scientific members and, further, it met in midsummer. The Naturalists met at Christmas time.

At first all the natural sciences were represented in the Naturalists. Soon fission began. The Geologists withdrew—next the Physiologists—then other groups, and so the parent society of Naturalists kept on budding until it was reduced to something like a nucleus without cytoplasm.

Our interest lies in the event which gave rise to the Physiologists in 1887. At that time the better textbooks of physiology were that of Dalton—widely used, a pirated edition of Foster at 95 cents—and Hermann's Handbook, of which there was, I think, only one copy in the country. But physiology was in the act of declaring its independence, and the names of its representatives that occur to me are Bowditch in Boston; Chittenden in New Haven; Dalton and Curtiss in New York; Weir Mitchell, Chapman, Brubacker and Reichert in Philadelphia; and Martin, Sewall and Howell in Baltimore.

It was, I believe, at the suggestion of Weir Mitchell that a Physiological Society was formed, and the organization meeting was in 1887. During the first ten years Weir Mitchell, Bowditch and Chittenden were the presidents. There were some 15 to 20 of us, and the sessions were short.

The isolation of the mammalian heart, which is credited to Martin, served as the starting point for a number of investigations from Baltimore. There were studies in the early phases of biological chemistry by Chittenden, and Bowditch was working with the plethysmograph. At one of the early meetings we were gathered in Bowditch's new laboratory—a great room two stories high. Half way up the walls a balcony ran all around, and from this innumerable wires were strung across. Physiology was mainly in the mechanical phase of its development. Bowditch, who was a clever mechanician, had, as demonstration, a cat with plethysmographs on each of its four legs. Each of these was so arranged as to give typed records of the changes in each limb, with a corresponding graph.

It was a remarkable set-up, and the graphs were strikingly smooth—yet now and then a disturbing deviation appeared. Some one said to Bowditch, "What do the irregularities mean?" To which Bowditch replied, 'Oh, that's due to the animal"—adding with a twinkle, "But we are trying to arrange it so as to dispense with the cat."

Such were the activities of the Physiologists in the middle eighties. They looked forward to the future with both hope and confidence—but to the men of that time a meeting like this present one would be, and is, astounding.

Specialization after specialization has followed with the years—but our views concerning such have improved. I recall that a delinquent member of the Physiologists met a couple of us on the train as we were returning from a meeting, and remarked, "I've been up in Cambridge talking with some literary chaps, but I suppose that wouldn't have any interest for you fellows." Thank heaven, that attitude of the specialist is fast disappearing, and being replaced by the better notion that a specialty is merely one point on which all worth-while knowledge can be focused.

By reason of this subdivision of interest, we are ever threatened by that tidal wave of literature that sweeps down on us from year to year—but the present efforts to synthesize our knowledge, if vigorously pushed, may furnish a protection, and save us from the predicament of one of Wellington's staff. This officer had held forth in great detail. "Sir," said the Iron Duke, "your information is too great for your understanding"—a cogent comment.

One word in closing: Martin brought to us the concept of biology, and the idea of special laboratories for physiology. The event has had far-reaching effects. It led to the founding of the Physiological Society and is the reason why, to-day, we are a Federation of Societies for Experimental Biology—ever expanding.

SCIENTIFIC EVENTS

THE SEVENTY-FIFTH ANNIVERSARY OF THE OLD SOUTH KENSINGTON MUSEUM

This year is the seventy-fifth anniversary of the opening of the old South Kensington Museum, and arrangements are being made, according to the London *Times,* in the Science Museum, which contains many of the original objects assembled in 1857, for a comparative exhibition illustrating the development which has since taken place in inventions. The original South Kensington Museum (in which the nucleus of the present Victoria and Albert Museum was also included) was founded as a result of the second report of the Royal Commissioners of the Exhibition of 1851.

The entrance hall of the present Science Museum and Gallery I, which adjoins it, were being cleared during the week-end in preparation for the anniversary exhibition, which will be open to the public on July 2. The exhibition will select the terminal points in a few branches of science which were at a primitive stage during the fifties and sixties. A model of an omnibus of the 1850's and locomotive models of the next decade will be placed beside models of a modern London omnibus and of one of the latest L. M. S. locomotives.

In many of the galleries upstairs parts of the permanent exhibition will be rearranged and relabeled for the anniversary, and a space has already been cleared in the Chemistry Gallery for illustrating the range of colors and fabrics now available to the artificial dye industry. Some of the largest British firms of chemists and textile manufacturers are lending exhibits for this portion of the exhibition. It is also intended to illustrate the part taken by the 1851 commissioners in founding the museum and fostering it since that time. The Great Exhibition in Hyde Park, and the development of the site south of the Park into the Museum and College area of South Kensington will be seen in a series of water-colors and plans.

The experimental apparatus used at University College, Gower-street, by the late Sir William Ramsay, has been transferred on indefinite loan from the college to the Science Museum, where it is now partly arranged for view. The exhibits now to be seen include the blow-pipe with which Ramsay himself made most of the apparatus connected with his discoveries of rare gases.

Some new additions have also been made to the ship-model collection in the museum. A model of a Handley Page "Hannibal" type air liner has been presented by Imperial Airways, while the Sudan Government have given a primitive smith's forge of the type used at the present time by the natives of the Jur tribe, and used with some variations in Ancient Egypt some 35 centuries ago.

The museum workshops have reconstructed a Roman pertica, or 10 ft. measuring rod. A series of the metal caps and ends of such surveyors' rods were discovered at Pompeii in 1912 by Cav. M. Della Corte, and replicas of these have been used in the museum.

SMITHSONIAN EXPEDITIONS

Twenty-five scientific expeditions were sent out by the Smithsonian Institution during the past year. They are described in detail in the annual Smithsonian exploration reports recently issued for distribution.

A. F. Moore, of the staff of the Smithsonian Astrophysical Observatory, spent months on barren peaks of African mountains in futile search for a satisfactory Old World site for a solar radiation station. He sought a high desert altitude with, so far as possible, a cloudless, dustless atmosphere. For more than a month he made daily observations on a high peak on Fogo Island in the Cape Verde group. Although generally cloudless, this mountain proved to be surmounted nearly all the time by a high, thick blanket of haze which seems to rise from the Sahara desert.

Disappointed here, Mr. Moore went on to Southwest Africa where, sometimes for weeks at a time, he conducted observations on four mountain peaks and made an unsuccessful effort to scale a fifth. None proved entirely satisfactory.

More than 600 specimens of fossil animals, mostly fragmentary, were collected under the direction of Dr. Charles W. Gilmore in Montana and Wyoming. It is anticipated that many new forms of animal life will be revealed when a systematic study is made. Material of interest included a partial skeleton of a large, flesh-eating mammal, the pachyaena; three partial skeletons of the coryphodon, a rhinoceros-like animal, and six more or less complete skulls of ancient crocodiles. More than 2,500 fossil specimens were secured in Devonian-age deposits in eastern New York by G. Arthur Cooper, of the Smithsonian division of invertebrate paleontology. Most of these were recovered from the numerous ravines and quarries around Cazenovia, Morrisville, and Hamilton, N. Y. The majority of the entombed animals are invertebrates, including nearly 150 species of ancient clams.

Dr. Alexander Wetmore, assistant secretary of the institution, hunted rare birds in dense rain forest and on high mountains in Haiti. Following an airplane reconnaissance of the little known La Hotte Mountains, which required little more than three hours, Dr. Wetmore and his party set out to reach this region with a pack train. At the end of six days of almost constant rain, over trails whose steepness and badness beggars description, they reached a point where the pack animals could go no further and they were obliged to proceed with a train of porters. The party pitched camp at an elevation of 4,200 feet and, drenched with incessant rain, climbed to the highest peak of the La Hotte range. They found a very abundant bird life and made a large collection for the United States National Museum. The party then proceeded to the Dominican Republic. Among the birds collected on the island of Beata off the Dominican coast was a hitherto unknown variety of wood warbler.

Dr. William M. Mann, director of the National Zoological Park, collected wild animals in British Guiana. Dr. Mann was seeking especially for reptiles. Among his captives was a small, brilliant red and black burrowing snake related to the boas which probably was the first of its kind to come alive into any collection. Another curious captive was a "jumping johnnie," a small snake with the under side of its tail colored a brilliant red. When picked up it goes through the motions of stinging with this tail, hitting the hand that holds it again and again with the brilliant red tip. It is harmless. Dr. Mann collected in all 350 live specimens, some representing varieties seldom seen in captivity. There were 128 birds, 21 mammals and 189 reptiles.

Dr. Paul Bartsch, curator of mollusks, continued his biological explorations in the Tortugas. He reports one interesting observation on the ability of birds to adjust themselves to a change in environment. On one "key" he found that all the trees, bushes and shrubs had been swept away by hurricanes. Great numbers of noddy terns used to build their nests in the vegetation. He found that now all have changed to a ground dwelling habit. Still retaining the desire to make nests they gather bits of dead twigs and shape them into semblances of nests on the ground. The birds, Dr. Bartsch said, seem to have a decided "lingo-tactic sense," for old boards seem to satisfy their desire for wooden homes. Birds were found incubating their eggs upon bare boards.

GEOLOGY, PHYSIOGRAPHY AND ECOLOGY AT THE PULLMAN MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FOR those interested in the geology, physiography or special problems of ecology of the "Inland Empire" of the Pacific Northwest, a rare feast is spread for the Pacific Division of the American Association for the Advancement of Science, meeting in Pullman, Washington, from June 15 to 18. On the general program, Dr. J Harlen Bretz, of Chicago University, will speak on his investigations of the scablands of the Columbia Plateau and will conduct a party to the field to study at first hand this unique problem of Pleistocene erosion. The Palouse Hills in which Pullman is situated, in themselves, present an inviting study as to their genesis, and will be a revelation to all comers who have not seen approaching harvest in the wheat fields which cover them. The farm and laboratory of the new U. S. Station for Erosion Control will be suggestive of what the immediate future may have in store in moisture control for agriculture. Several short local excursions are planned and two more extended ones, in addition to that with Dr. Bretz, will attract to more distant points of interest. One of these will be a boat excursion up the canyon of the Snake River from Lewiston, Idaho, to a point where the depth of the gorge, approximately 6,000 feet, rivals that of the Grand Canyon of the Colorado. Those who have made this boat trip describe it as unforgettable. Perhaps most delightful of all, because less hurried and inviting leisurely travel and prolonged stay, will be the excursion to the almost wholly unknown Wallowa Mountains of northeastern Oregon, and the new Eagle Cap Primitive Area in these highlands. A hasty survey[1] of this region in the summer of 1931, together with Professor Warren D. Smith's very readable account,[2] have given the writer the impression of a dome-like uplift of late Miocene time which carried Columbia basalts almost to its crest at an original elevation of between ten and twelve thousand feet. At the northeastern side this dome gave way in a great down fault of about thirty miles' length with a scarp of about 4,000 feet above the plain (Wallowa Valley). A Pleistocene ice-cap formed about Eagle Cap Mountain and no less than five glaciers carved deep gorges down to the level of the plain on northern and eastern sides of the dome. These are the canyons of Lostine River, Hurricane Creek, Wallowa River, Big Sheep Creek (perhaps) and Imnaha River. The alpine sculpture is magnificent. To the physiographer, the unusually perfect state of preservation of the moraine which encloses Wallowa Lake is most impressive. The lateral moraines reach a height of 700 feet above the water level of the lake and the steepness of the inner slope is quite unbelievable. Professor Smith finds the outer slope records five advances of the ice. Only at the outlet of the lake is any part of the moraine disturbed since the recession of the ice.

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[1] Observations here recorded were made possible by a grant for research in this region by the Research Committee of the National Society of Sigma Xi.

[2] Warren D. Smith, "Wallowa Mountains and County," Commonwealth Review of University of Oregon, January, 1928.

To the ecologist this oasis in the midst of semidesert (Upper Sonoran), with lush temperate vegetation in lower valleys, extending upward to alpine, is a paradise for exploration.

As mountaineering goes, one reaches all these charming possibilities with absurd ease from the friendly little agricultural villages of Enterprise, Joseph, Lostine and Wallowa. The car is parked at the end of a good forest road two thirds of the distance between the entrance of the mountain valley and the base of Eagle Cap. Nine miles of good foot or horse trail reaches the lake basin at about 8,000 feet elevation and surrounding peaks reach about 9,800.

THOMAS LARGE

SPOKANE, WASHINGTON

THE SCHOOL OF ENGINEERING OF YALE UNIVERSITY

THE Yale Corporation has authorized the existing division of engineering to assume the status of a school with the title of the Yale School of Engineering. The school will include the functions and activities in civil engineering (including drawing), chemical, electrical and mechanical engineering, metallurgy and engineering mechanics.

This organization is the result of a proposal made by a committee which for over a year has been studying the teaching of science and engineering at the university. It has long been desired by the departments of engineering, and the recommendation has the approval of the Board of Permanent Officers of the Sheffield Scientific School.

Dean Charles H. Warren, of the Sheffield Scientific School, in explaining the organization of the Engineering School, said in part:

> Previous to 1919 all instruction at Yale in engineering was given in the Sheffield Scientific School. After the reorganization of the university in that year undergraduate instruction in engineering remained in the Scientific School, but the graduate work was transferred to the Graduate School.
>
> Believing that engineering work of all grades, together with research and other activities in the engineering departments, constitutes a distinctive unit within the university requiring a unified control for its administration and the satisfactory coordination of its parts, the Division of Engineering, which includes the several engineering departments, has for some years performed what are virtually the functions of a faculty of engineering. Their recommendations have, however, been subject to the approval of the boards of the Scientific School and the Graduate School, respectively, and the activities of the engineering departments have in general been under the dual control.
>
> While this arrangement has worked reasonably well, it is from the administrative point of view needlessly cumbersome, and furthermore it has been felt by the engineers that the interests of engineering would be advanced more rapidly if the engineering departments were given the status of a school of engineering under its own dean and board of permanent officers, a form of organization which has long since been followed by every other university in the country.
>
> Under this new arrangement all students of engineering will from now on be under the jurisdiction of an engineering faculty, and the engineering degrees will be conferred upon its recommendation. This change will not, however, modify in any essential particular the general conduct of the instructional work, nor the other activities of the engineering departments. Undergraduate students will be admitted, as in the past, to the freshman year and from it will enter the undergraduate department of the engineering school. Their relations with other undergraduates, and in regard to all social and extra-curricular activities, will remain exactly as at present.

SCIENTIFIC NOTES AND NEWS

A DINNER in honor of Dr. Ernest W. Brown, Gibbs professor of mathematics at Yale University, who becomes professor emeritus at the end of the academic year, was held at the New Haven Lawn Club on May 24. The dinner was given by members of the three university departments with which Professor Brown has been associated: astronomy, mathematics and physics. Dean Clarence W. Mendell was toastmaster. Addresses were given by Dr. Frank Schlesinger, director of the University Observatory; Professor Oystein Ore, director of graduate studies in mathematics; Governor Wilbur Cross, dean emeritus of the Graduate School, and President James Rowland Angell.

THE degree of honorary doctor of veterinary medicine was conferred upon Dr. Theobald Smith, of the Rockefeller Institute for Medical Research, by the

University of Giessen at the hundredth anniversary of the granting of veterinary degrees.

AT the sixty-ninth commencement of the University of California, the degree of doctor of laws was conferred on Dr. Joseph Erlanger, professor of physiology in the Washington University (St. Louis) School of Medicine.

THE honorary degree of doctor of science was conferred upon Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, on the occasion of the thirty-third commencement of Clarkson College, Potsdam, New York. Dr. Compton made the principal address.

ACADIA UNIVERSITY, Wolfville, Nova Scotia, at its ninety-fourth commencement, conferred the honorary doctorate of science on Laurie D. Cox, professor of landscape engineering at the New York State College of Forestry, Syracuse, and the honorary degree of doctor in civil law on Merritt Lyndon Fernald, Fisher professor of natural history in Harvard University.

AT the commencement exercises of the Worcester Polytechnic Institute on June 17, the honorary degree of doctor of engineering will be conferred on four graduates of the college. They are: Leon P. Alford, vice-president of the Ronald Press Company, New York; John J. Donovan, vice-president of the Bloedel-Donovan Lumber Mills; Alfred D. Flinn, director of the Engineering Foundation, New York, and George W. Patterson, powder expert at the Naval Powder Factory. Mr. Donovan will deliver the commencement address.

HONORARY degrees conferred by Columbia University at commencement included the doctorate of science on Dr. Dugald C. Jackson, professor of electric power production and distribution at the Massachusetts Institute of Technology. The citation by President Butler read: "Dugald Caleb Jackson, professor in the Massachusetts Institute of Technology, native of Pennsylvania, and trained at Pennsylvania State College and at Cornell University; closely uniting industrial experience with scientific research, and, after sixteen years of service at the University of Wisconsin, passing a quarter-century ago to the department of electrical engineering at the Massachusetts Institute of Technology, active in a score of ways as engineer, as educator and as administrator; honored at home and abroad for distinction of mind and of service marked by broad vision, boundless energy and vigorous leadership; a true ornament of our country's scientific endeavor and of its educational force."

THE Roosevelt medal for distinguished service has been awarded to Dr. Robert A. Millikan and will be presented to him at a dinner to be given on the seventy-fourth anniversary of President Roosevelt's birthday, on the evening of October 27. Heretofore since the establishment of the medal in 1923 three awards have been made annually. In a statement announcing the single award this year, Dr. James R. Garfield, president of the Roosevelt Memorial Association, said: "Dr. Millikan combines in a striking degree the qualities of a scientist, an administrator, a teacher, a philosopher and public servant. He has been conspicuous in the movement of scientific speculation away from the materialistic and mechanistic theories of the nineteenth century toward spiritual conceptions in harmony with the aspirations of religion."

THE Lamme medals of the Ohio State University, for "meritorious achievements in engineering and the technical arts," will be presented to Albert V. Bleininger, chemist to the Homer Laughlin China Company, and to Ralph D. Mershon, consulting engineer and chemist, New York, at the fifty-fifth commencement on June 13.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, has been elected a corresponding member of the Geological Society of Belgium.

THE Jacksonian Prize for 1931 of the Royal College of Surgeons has been awarded to J. Paterson Ross, of St. Bartholomew's Hospital, for his essay on the surgery of the sympathetic nervous system. A certificate of honorable mention for an essay on the same subject was granted to Lambert Charles Rogers, of the Royal Infirmary, Cardiff.

PROFESSOR GIUSEPPE PIANESE, professor of anatomy and pathological histology at the University of Naples, was recently appointed an academician of Italy.

DR. ROBERT A. MILLIKAN, of the California Institute of Technology, was reelected president of the board of directors of the National Advisory Council on Radio in Education at the second annual assembly in Buffalo, New York, held from May 18 to 20. Other officers reelected were: *vice-presidents,* Livingston Farrand, Meta Glass, Robert M. Hutchins, Michael I. Pupin, Walter Dill Scott; *chairman of the board,* Norman H. Davis; *vice-chairman,* William J. Donovan; *treasurer,* Ralph Hayes; *secretary and director,* Levering Tyson.

THE Botanical Society of New Orleans has elected the following officers for the year 1932–33: Dr. L. J. Pessin, associate ecologist, Southern Forest Experiment Station, *president;* Miss Anna Haas, *vice-president;* Philip C. Wakeley, associate silviculturist, Southern Forest Experiment Station, *secretary,* and Paul V. Siggers, Bureau of Plant Industry, *treasurer.*

At the annual dinner of the society on May 10, Dr. Miriam L. Bomhard, assistant professor of biology at Newcomb College, spoke on "Palms in New Orleans."

HENRY HARRISON HENLINE, assistant national secretary of the American Institute of Electrical Engineers since 1927, has been appointed acting national secretary of the institute. Mr. Henline was appointed to fill the vacancy created by the death in February of F. L. Hutchinson who had been national secretary for twenty years.

PROFESSOR LEON B. RICHARDSON, of the department of chemistry of Dartmouth College, has succeeded Professor W. S. Messer as president of the college chapter of the American Association of University Professors.

DR. MORRIS SCHERAGO, head of the department of bacteriology at the University of Kentucky, has been elected an associate member of the American Society of Clinical Pathologists.

DR. GEORGE S. BEL, emeritus professor of theory and practice of medicine and clinical medicine, Tulane University of Louisiana School of Medicine, New Orleans, has been appointed professor of the principles and practice of medicine in Louisiana State University Medical Center, succeeding the late Dr. James Birney Guthrie.

THE department of zoology at the University of Minnesota announces the appointment of Dr. Clarence P. Oliver as assistant professor of zoology. Dr. Oliver will give the courses in genetics.

DR. ROBERT F. MEHL, assistant director of research for the American Rolling Mill Company, Middletown, Ohio, has been appointed as director of the bureau of metallurgical research at the Carnegie Institute of Technology. Under his direction and through a grant from the Carnegie Corporation the work of the laboratory will be extended.

DR. F. B. MUMFORD, dean of the University of Missouri and director of the Agricultural Experiment Station, has returned from six months' absence in European countries, where he made a study of agricultural education and research, and of what governments are doing to aid agriculture. Dr. A. E. Murneek, associate professor of horticulture, has returned from a similar absence spent in studying the work being done by institutions in eastern and central Europe and in Russia in the field of plant physiology.

DR. GEORGE DOCK, Pasadena, California, formerly head of the department of medicine at the University of Michigan, will be this month the honor guest of the 1907 medical class at its twenty-fifth reunion. Dr. Dock will give a medical clinic at the University Hospital on June 18, to which former students and alumni are invited.

DR. HENRY J. GERSTENBERGER, professor of pediatrics in the School of Medicine of Western Reserve University, gave on May 24 the annual address before the Case Chapter of the Society of the Sigma Xi. His subject was "Studies in Human Rickets."

DR. W. F. G. SWANN, of the Bartol Research Foundation; Dr. Saul Dushman, of the General Electric Company; Professor Debye, of the University of Leipzig, and Professor Charles A. Kraus, of Brown University, are the special lecturers this summer in the department of physics of the Ohio State University. In the issue of SCIENCE for May 27, it was stated erroneously that the lectures were to be given at the University of Illinois.

A GRANT of $250.00 from the Committee of Scientific Research of the American Medical Association has been made to the department of physiology of the University of Cincinnati to further the work of Dr. Esther Bogen Tietz on pseudo-pregnancy in rabbits.

THE University of Maryland celebrated the one hundred and twenty-fifth anniversary of its founding on June 3. The exercises were held in Baltimore and at College Park. Speakers included Dr. William H. Welch, director emeritus, of the Johns Hopkins University Institute of the History of Medicine, and John H. Finley, associate editor of *The New York Times.*

WE learn from *Nature* that the Fifth International Congress of Scientific Management will be held at the Koloniaal Instituut, Amsterdam, from July 18 to 23. The subjects to be discussed include costing, markets, technical and mental education of foremen for rationalization, systems of promotion, rationalization as a part of education, costs of retail distribution, agricultural labor and rationalization in various types of industry. Papers from many countries have been contributed through the national associations or committees and are being published in two volumes in advance of the meeting; summaries only will be read at the sessions of the congress. Excursions in Amsterdam, to Eindhoven, the Zuider Zee and to Rotterdam are being arranged, and continental railways are giving special facilities for those attending the congress. The general secretary for the congress is Mr. V. W. van Gogh, Herrengracht 209, Amsterdam.

AT the House of the Royal Society of Medicine on May 19, Sir Charles Sherrington, the recent Hughlings Jackson lecturer, was presented with the Hughlings Jackson gold medal together with an honorarium of 100 guineas. The presentation was made by Dr. T. Watts Eden, president of the Royal Society of

Medicine. The London *Times* recalls that the Hughlings Jackson lecture was founded in 1897 to honor Dr. Hughlings Jackson, and in recognition of his service to humanity by his work on the functions of the nervous system. For some time it has been felt that so important a commemoration lecture should not go unendowed. Subscriptions for an endowment were invited from neurologists all over the world, and with the money raised the Hughlings Jackson lecturers will receive a gold medal and an honorarium of 100 guineas. Sir Charles Sherrington is the first lecturer to receive the medal and honorarium. He also receives the diploma of honorary membership of the Section of Neurology of the Royal Society of Medicine. After the presentation Sir James Crichton-Browne gave personal reminiscences of Dr. Hughlings Jackson, and Mr. Leslie Paton (chairman of the Fund Committee) presented Dr. Watts Eden with two silver replicas of the medal for the Royal Society of Medicine. The design for the gold medal is the work of Mr. Percy Metcalfe, and the dies have been prepared by the Royal Mint.

A CORRESPONDENT writes: "The Brooklyn Botanic Garden has recently inaugurated a feature which is probably unique for botanic gardens, and possibly unique in the way of geological education. This consists in placing on about twenty-eight boulders in the Botanic Garden small bronze tablets, giving the composition of the boulder, the geological age to which it belongs, stating that it was transported to the Botanic Garden by the continental ice sheet during the Ice Age, and giving approximate location of the rock ledge from which the boulder was dislodged. In connection with these labels, the Botanic Garden has edited a "Guide to Our Boulders; Geological History of the Brooklyn Botanic Garden." This appears as the May issue of the Brooklyn Botanic Garden *Record*. The principal part of the guide is written by Dr. Ernst Antevs—one of the leading authorities on certain aspects of glacial geology. It is richly illustrated with maps and views."

Nature states that Sir Frank Dyson, Astronomer Royal, opened the new Mond photographic equatorial and dome at the Norman Lockyer Observatory, Salcombe Regis, Sidmouth, on May 28. The Norman Lockyer Observatory is the only astronomical observatory in Great Britain founded and maintained by a private corporation under the Companies (Consolidation) Act of 1908. Since it was started, nearly twenty years ago, it has been equipped and maintained entirely by private donations. The equipment includes two twin telescopes, one with a 10 in. object glass and a 12 in. prismatic camera, and the other with a 10 in. object glass and a 9 in. prismatic camera for photographing the spectra of stars and other celestial bodies. A very large collection of such photographs, numbering 6,500, has already been taken at the observatory, affording valuable records of the nature and movements of objects in the stellar universe. Dr. Robert Mond, who has been a generous supporter of the observatory since it was founded, has now presented a unique photographic equatorial, with a separate building and dome to house it. The instrument consists of a battery of four cameras with clock mechanism, so that it will be possible to follow automatically movements of the heavens over a wide field of the sky.

A COLLECTION of Brazilian plants, gathered about a century ago by the Scandinavian naturalists, Eugene Warming and Wilhelm Lund, has been received at the Field Museum of Natural History from the University Museum of Copenhagen, Denmark.

SEVERAL members of the committee on fuels and lubricants of the American Society of Agricultural Engineers, of which R. B. Gray, chief of the division of mechanical equipment of the Bureau of Agricultural Engineering, of the U. S. Department of Agriculture, is chairman, recently visited a number of tractor and engine manufacturers in the Central West with a view to improving the performance and efficiency of tractors and engines.

A 50,000-ACRE national-forest tract in Montana has been set aside by the Forest Service as a "primitive area." The area, on the Gallatin-Madison County line in the Gallatin National Forest, abounds in flowers, trout and game, and includes the Spanish Peaks mountain group, widely known for its scenic grandeur, and about twenty beautiful, small alpine lakes. It is to be known as the Spanish Peaks Primitive Area.

CHINSEGUT HILL, a 2,082-acre tract in Hernando County, Florida, has been deeded by the owners, Colonel and Mrs. Raymond Robins, to the Department of Agriculture for use in the work of the department. The area will be used as a bird refuge; and also, in cooperation with the Florida Agricultural Experiment Station, in studies of problems relating to citrus fruits, livestock, feed and forage production and related problems. A diversity of cover and the existence of lakes and marshes lend additional value to the tract for the conservation of many species of wild life, including migratory birds. Great appreciation was expressed by Secretary Hyde and other officials of the department to Colonel and Mrs. Robins for their contribution to wild-life conservation and to the agricultural development of the South. The former owners will continue to live in the old mansion house on the area for such time as they desire.

DISCUSSION

SOLAR AND RADIO PERIODICITIES

AT the April, 1932, meeting of the National Academy of Sciences I gave a paper which has been published under the title "Periodicity in Solar Radiation," by C. G. Abbot and Gladys T. Bond (Smithsonian Misc. Coll., Vol. 87, No. 9). Dr. L. W. Austin has published "Tables of North Atlantic Radio Transmission Conditions for Long-wave Daylight Signals for the Years 1922–1930" (Proc. Radio Engineers, Vol. 20, No. 4). It occurred to Mrs. Bond and me to see whether the departures from monthly normals in radio transmission showed the seven periodicities of 7, 8, 11, 21, 25, 45 and 68 months, respectively, which occur in the variation of solar constant values. We therefore computed the monthly normals from Dr. Austin's figures, and obtained the departures of all his observed monthly radio transmission values, 1922–1930. This series we analyzed by the aid of the periodometer. We found the seven periodicities above named and one other of 18 months, all well indicated. Combined they account for all longer period radio transmission variations. On the whole, the amplitudes of the solar periods and of the radio periods run nearly parallel. The cycle of eighteen months, though not found in solar variations, is conspicuous in terrestrial temperatures, as pointed out in our paper above cited. The phase relations between solar and radio periodicities are very interesting. We hope to publish details of the investigation in the autumn, but believe that the readers of SCIENCE will be interested to know that periodicities in solar radiation seem to accompany periodicities in radio transmission.

C. G. ABBOT

REPORTS OF THE PRINCETON UNIVERSITY EXPEDITIONS TO PATAGONIA

1896–1899

THE late Mr. J. B. Hatcher, at that time curator of vertebrate paleontology in the Princeton Museum, planned these expeditions and raised the principal funds for them from the students who had been with him in his various western explorations.

The first and third of the expeditions comprised Mr. Hatcher and Mr. O. A. Peterson, now of the Carnegie Museum in Pittsburgh; and the second one, Mr. Hatcher, and Mr. Colburn, of Washington, as ornithologist.

The principal object of the expeditions was to collect the wonderful fossil mammals of the Santa Cruz formation, which had been made known to the world by the late Dr. F. Ameghino, of Buenos Aires. In this the work was eminently successful; but was so expanded as to cover a great many other fields, and very extensive collections of invertebrate fossils and of the recent mammals, birds, fishes, reptiles, fresh-water shells, plants, etc., of southern South America and Tierra del Fuego were made.

It was Mr. Hatcher's idea to publish this great wealth of new material in a series devoted to those topics alone; and when this project was laid before the late Mr. J. Pierpont Morgan, he generously contributed a large sum, which was at that time estimated to be sufficient for the whole publication. The various groups of fosils and recent animals and plants were entrusted for study and report to various specialists, nearly all of whom found it necessary to demand much more text and many more plates than they had originally estimated. The additional expense over the original scheme was met by contributions from the trustees of the Carnegie Institution of Washington and of Princeton University. Planned for six quarto volumes, the series has grown to twelve such volumes with three atlases of plates.

The first part was issued in the spring of 1901; the last part, concluding Volume VII, has just appeared. Needless to say, the editor is very much gratified at being able to issue the entire work over the thirty-one years which have elapsed since the publication of Part 1.

W. B. SCOTT
Editor

PLEISTOCENE MAN IN MINNESOTA[1]

DR. FRANK LEVERETT, geologist of the U. S. Geological Survey, prepared volume number 12 of the Minnesota Geological Survey, under Director Professor William H. Emmons. The volume is entitled "Surface Formations and Agricultural Conditions of Northwestern Minnesota." It was published in 1914. On sheet 1 of the map accompanying said volume Dr. Leverett shows certain "clayey lake beds," designated "L C"—one of which in Ottertail County is now of peculiar importance. The legend on the map which describes these clayey lake beds reads, "Chiefly in low part of areas of extinct lakes where fine material found lodgement below level of wave action."

From twelve feet beneath the existing varved silt which in glacial time flowed into and filled the ancient lake in Ottertail County, a human skeleton has been recovered under controlled and documented conditions.

May 7, 1932, Drs. C. R. Stauffer, G. A. Thiel, geologists, and F. K. Butters, botanist, colleagues in the University of Minnesota, visited the site of the find and, in agreement, bear scientific testimony concerning the geological nature of the extinct lake from whose silted depths the human skeleton was rescued.

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[1] A preliminary announcement.

Together the three above scientists and the writer dug out anew the spot where the skeleton was found. There we secured seven fragments still in place which are additional parts of the original fossil materials in my laboratory. We thus authenticated the exact site of the find which had fortunately been documented by a diary entry written on the spot by the road boss on the day of the discovery. Even in this preliminary announcement, I must note the cooperative and intelligent interest, in the matter of this find, of the following gentlemen connected with the Minnesota State Highway Commission, namely Messrs. C. M. Babcock, P. F. Stary, Clarence Wright and C. A. Steffen. In the face of the state program for extensive road building, we had written asking to be informed of such possible finds of ancient man as might be exposed by extensive earth cuts made during road work. The recovery, preservation and initial information of the subject of this announcement is one of the fortunate results of this state-wide cooperation.

Our extinct glacial lake had existed earlier than most of the extensive world-famous Glacial Lake Agassiz. It now seems probable that the extinct lake of our immediate interest may have been contemporaneous with an early stage of Glacial Lake Agassiz—*i.e.*, with Agassiz when it was only about 120 miles long, north and south, and only some 40 to 50 miles wide. Its eastern border was then confined by glacial ice or by the Leaf Hills Moraine (also close within which ice or moraine our lesser lake probably then existed farther to the east). At the north, Agassiz was then confined by glacial ice which, as it melted in retreat, left the Fergus Falls Moraine and the Leaf Hills Moraine on the north and northwest. Thus as early as 1895, or 37 years ago, Dr. Warren Upham had published authoritative data which will be of value in the geological dating of our Pleistocene skeleton in his book, "The Glacial Lake Agassiz," volume 25 of the United States Geological Survey. In its early phases of existence, Glacial Lake Agassiz drained southward through the present Minnesota River, starting near what is now Lake Traverse. That early outlet of Agassiz was several miles southwest of and a few hundred feet lower than the lake beneath whose ancient silt the skeleton was discovered. The varved silt bed covers points in the near-by topography at least fifty feet higher than the point where the skeleton was found and where it had originally been naturally deposited under the undisturbed varved silt. The lake had been filled with silt in the form of "rock flour" washed out from beneath the near-by glacier. The fine silt had settled seasonally in thin even layers. To-day the varves still lie horizontally just as they had been deposited in the glacial lake below the level of wave action.

The skeleton recovered is of a youth under twenty years of age. The skull is of a primitive *Homo* who, of course, must have been of an American ancestral type. The nasal aperture has distinctly simian sill and borders. There is no projecting nasal spine. The teeth are unusually large. There is a marked degree of prognathism. The sagittal suture is extremely simple. So far as reconstruction and measurements have progressed, the type of man revealed is suggestively more proto-Eskimo than proto-Indian. The body apparently had originally all been in the lake in the spot where the skeleton was so largely recovered. With exception of the bones of hands and feet, the entire body is well represented in the parts we now possess.

It is interesting also that artifacts were found with the skeleton, including a crude dagger of antler and a large pendant of shell—both of which had been attached to and worn by the youth, as each has a hole for a leash.

Complete scientific data will later be presented on this Pleistocene man—which, for purposes of identification, we name "the Minnesota man."

ALBERT ERNEST JENKS
UNIVERSITY OF MINNESOTA

THE LITERATURE OF TAXONOMY

IN a paper entitled "A New View-Point in Paleontology,"[1] Dr. E. M. Kindle outlines the difficulties which confront the paleontologist who attempts to use—or find—the scattered literature of taxonomy. As a partial remedy for the situation, he proposes the republication, upon standardized cards, of original descriptions and figures, with such supplementary material as is essential to their use. This card catalogue is to be prepared first for Devonian invertebrates of North America; upon it, fourteen or fifteen paleontologists already are working, or have agreed to work.

Being members of these fifteen, with copy for more than eight hundred cards describing sponges, stromatoporoids and sponges already in our files, we recognize the value of Dr. Kindle's suggestion. Probably it offers greater aid to working paleontologists—especially those in institutions whose libraries are small and poorly supported—than does any other he could have made.

Yet it seems to us that such a catalogue solves only present and past problems. Unless it is accompanied by a plan for future publication, also upon standardized cards, the present situation is bound to be repeated as new species and subspecies are described.

Nor does it seem enough to provide for additions to the catalogue, in the form of cards reproducing future source material. That would mean that the expense of publication must be borne twice: once by the journal or institution printing the author's paper, and once by the institution sponsoring the catalogue. One of these costs would be waste—and the money, if spent, should go into productive publication.

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[1] Trans. Royal Soc. Canada, 25, sec. 4: 21–27, 1931.

We suggest, therefore, that while efforts are being made upon the catalogue, as originally conceived by Dr. Kindle, and sponsored by the Paleontological Society, others be devoted to the problem of providing original publication, upon cards, of future original paleontologic descriptions and of significant revisionary material. This plan will demand, of course, funds for printing and for maintaining a central office where cards may be edited, published and sold; as well as international cooperation among contributing agencies and authors.

We do not minimize these problems of securing support, but the rewards to be achieved command attention. Instead of a future of widely scattered descriptions, periodically assembled and republished upon cards, the paleontologist would have those cards, bearing initial descriptions and figures, and available from a central office. Single species, instead of being buried in papers on stratigraphy, areal or economic geology, would appear upon individual cards, each under its own name and readily discoverable. Authors need not wait for the completion of long papers—nor will they resort to the almost useless "preliminary description," often published to establish priority rather than to enlighten its users. By the use of cards, one species may be published as readily as a dozen, and as readily found by other workers. The fear that a description may become "buried" will haunt neither its author nor the subsequent student, who will find the sources that he needs for study available without extended search, at a price which (if necessary) he himself can pay.

MILDRED ADAMS FENTON
CARROLL LANE FENTON

WEST LIBERTY, IOWA

AN APPEAL TO AMERICAN BIOCHEMISTS

J. L. W. THUDICHUM, pupil of Liebig, has been recognized for many years as one of the great biochemists. His splendid contributions in the field of lipoid chemistry (chemistry of brain tissue) are well known. His contributions in pigment biochemistry, not as well recognized, were also fundamental. He was the pioneer investigator of the pigments, named by him "luteins," now known as carotinoids. He also contributed outstanding papers upon the urinary pigments, bile pigments and hematoporphyrin, which he recognized as appearing in other sources besides the blood. The amino-acid "norleucin" was originally discovered by Thudichum. A number of other substances of biochemical interest began their existence as entities in the laboratory of this unusual worker, although they were rediscovered and renamed by later investigators. In the interest of science Thudichum wrote numerous texts, all replete with profound historical introductions, upon many divergent topics.

Thudichum also, somehow, found time to carry on a medical practice, using a good deal of his income to purchase platinum utensils, etc., for carrying on his researches, many of which were conducted in his private laboratory.

An interchange of communications with Dr. Otto Rosenheim (London), who for many years has been collecting data upon Thudichum's life, has brought the information that the five daughters of Thudichum are in dire financial need. The members of the American Society of Biological Chemists and others who care to do so may contribute towards a fund for them. Contributions, however small, will be highly appreciated. Checks may be mailed to Dr. David L. Drabkin, Medical School of the University of Pennsylvania, who will transmit the collected fund as a contribution of American biochemists to the parties abroad.

RUSSELL H. CHITTENDEN
PHOEBUS A. LEVENE
LAFAYETTE B. MENDEL

CONFERENCE ON ASTROPHOTOGRAPHIC PROBLEMS

A CONFERENCE on Astrophotographic Problems was held at the Harvard Observatory on March 23, on the occasion of the dedication of the new astrophotographic building. The building contains the large collection of photographic plates, the library of the observatory and many offices.

The following are abstracts of the papers presented:

The Harvard collection of astronomical photographs: ANNIE J. CANNON. The history of astronomical photography at the Harvard Observatory dates from 1850, when the first photograph of a star ever taken was made here with the 15-inch equatorial telescope. Since that time the collection of plates has grown steadily, and it now contains about 400,000 glass negatives, of sizes from 4 x 5 inches to 14 x 17 inches. The earliest plates, obtained in 1850–1852, were daguerreotypes taken under the direction of William C. Bond, the first director of the observatory. The process was so slow that only the brightest stars would "take," and no impression could be made of the North Star, however long the exposure. The introduction of "wet" collodion plates brought new hope, and George P. Bond, the son and successor of William Bond, succeeded in 1857 in photographing by their use stars of the sixth magnitude, which includes all visible to the naked eye. About one hundred plates of this period are still in good condition. The Harvard collection forms a continuous series from 1885, when dry plates were first available. At that time Edward C. Pickering, the fourth director of the observatory, started with great zeal and enthusiasm on the large task of photographing the whole sky. The Bache fund enabled him to secure an 8-inch photographic lens which has been continually in service since that early day. With the help of Mrs. Henry Draper, of New York City, who established the Henry Draper Memorial, and of the Boyden fund for the erection of an observatory at a high altitude, four photographic telescopes were installed between 1885 and 1890, two in Cambridge and two in Peru. Up to the present time, these four telescopes have taken 142,000 plates. The results of a study of these plates include the discovery of the first spectroscopic binary; of one thousand variable stars, in globular clusters and elsewhere, and of ten novae; as well as the spectral classification of 225,000 stars, and the establishment of an international system of stellar magnitudes. In 1893, by the generous gift of $50,000 from Miss Catharine Bruce, of New York City, a 24-inch doublet was ordered by Professor Pickering from Alvan Clark and Sons, and was sent to the Boyden station at Arequipa, Peru, at an elevation of 8,000 feet. Although the construction of a doublet of such unprecedented size was strongly criticized in those days, the telescope has been effective, and is responsible for 16,000 negatives in the Harvard collection. The revelations from the Bruce plates include the faint ninth satellite of Saturn, Phoebe; numerous studies of the Magellanic Clouds, including the discovery in them of more than two thousand variable stars, and of the period-luminosity relation, one of the most effective measuring tapes for determining the scale of the universe. At least thirty thousand spiral nebulae have also been discovered by means of the Bruce telescope. Three other telescopes, for which the lenses were ground by the late Reverend Joel Metcalf, have taken about 45,000 photographs, on some of which over 2,500 variable stars have been discovered in the Milky Way regions. Forty-one minor planets were discovered by Dr. Metcalf on plates which he took with his 12-inch lens, plates later donated by Mrs. Metcalf to this observatory. For thirty years small photographic telescopes, with lenses of one-inch aperture, have patrolled the northern and southern sky, so that for observational work there are often semi-monthly plates of various parts of the sky, showing stars down to the eleventh or twelfth magnitudes. The Harvard Map of the Sky was made from these plates, from studies of which many variable stars and eighteen novae have been found. In 1927 the Boyden station was moved from Arequipa, Peru, to Bloemfontein, South Africa, by Dr. Shapley, fifth director of the observatory. Excellent prospects for a bright future in the photography of the southern stars are promised by modern mountings for the old instruments, a new Ross-Fecker lens for patrol work and a 60-inch reflector for detailed investigations. The prospective removal of the Cambridge photographic instruments to Oak Ridge in the town of Harvard, comparatively free from smoke and electric lights, will be of great advantage in the photography of the northern stars. And the completion of the new fireproof structure to house the negatives will insure for many years to come the usefulness of the Harvard Collection of Astronomical Photographs.

The chemistry of the photographic process: G. B. KISTIAKOWSKY.[1] The problem of the chemical processes that occur in the production of an image on a photographic plate has long been a very difficult one. It is possible to do little more than present the attitude of modern physicists and chemists towards theories of the way in which light acts on the silver salt grains in the photographic emulsion, and the way in which the silver salt (such as silver bromide) is changed, by developing the plate, into metallic silver. Observation shows that development starts at the edge of the microscopic grain, and that its occurrence depends on the presence of smaller specks of silver sulphide in the grain. These specks of silver sulphide are produced during the "ripening" of the emulsion (effected by adding ammonia to the emulsion, and heating) by a minute quantity of sulphur compound contained in the gelatin. The presence of this sulphur is due, curiously enough, to mustard plants in the diet of the cattle from whose bones the gelatin is made (and gelatin made from cattle whose diet contains no mustard is found to be inferior for this purpose). It seems possible that the bromine atoms travel around until they encounter these "sensitivity specks" of silver sulphide, and that a reaction then starts which makes the whole grain of emulsion developable. There was a hypothesis that the light quanta falling on the plate acted upon individual silver bromide molecules, separating them into silver and bromine; but this hypothesis seems to be refuted by several properties of the photographic emulsion, such as the fact that the light must be of a certain minimum strength to make an impression on the plate at all; very weak light produces no image. An important modern branch of photography treats of the action of certain dyes on the emulsion, making the plate sensitive to other colors than blue and violet. A noteworthy example of such a dye is the one used by the Eastman Kodak Company in making a plate that is sensitive to the infra-red rays of light that are invisible to the eye. The way in which the dyes work is very imperfectly understood. Much remains to be done in photography as an art, as distinct from photography as a science; and the fundamentals for understanding the reactions that are used in photography are the materials for further research by the chemist.

[1] Professor of Chemistry, Harvard University.

A survey of photographic astrometry: FRANK SCHLESINGER.[3] Pioneer work in photographic astrometry was done at the Harvard Observatory by Bond. Especial tribute should also be paid to the painstaking investigations which Rutherfurd made in his private observatory at 11th Street and Second Avenue, New York City. Rutherfurd showed definitely, as early as 1865, that star positions could be measured with great accuracy from photographic plates and that the much disputed distortion of the film did not affect the measurements seriously. Rutherfurd's early optimism was more than justified; at present one measurement from a photographic plate can compete in accuracy with ten visual measurements made with a telescope of the same focal length. In 1886 and 1887, conferences of some of the world's most prominent astronomers met in Paris to consider the project of making a photographic map of the whole sky containing stars one thousand times fainter than the faintest star visible to the naked eye. The accuracy with which star positions can now be photographically measured is very great; the accidental error of measurement is equal to only 0.000,020 inch, or 0.0005 mm. In conclusion, some of the most important future problems in this field should be mentioned. Our knowledge of the radial velocities of the stars (motions directly towards us or away from us) is very meager for the fainter stars. Progress in such work can only be expected after what may prove to be a long period of trial and experiment. Success in determining radial velocities by means of the objective prism does not look less promising to us now than was the prospect of determining radial velocities by any method forty years ago. The importance of being able to determine velocities in this way is so great as to warrant years of patient effort on the part of many workers. The importance must again be emphasized of a close cooperation between the astronomer and the chemist who specializes in the chemistry of photography. Astrometry will enter a new era if a method can be found for eliminating the inherent inaccuracies in the measurement of positions on the photographic plate. The cause of these inaccuracies is still to some extent a mystery, but it appears certain that the major source of inaccuracy lies in the plate itself and not in the methods now at hand for measuring it.

The current photographic programs of the Harvard Observatory: HARLOW SHAPLEY. Seven major observing programs and eleven smaller programs are in operation with the Harvard telescopes; nine instruments are in continual use on the programs at the Cambridge station, five at the South African station, and three special cameras with the meteor expedition at Flagstaff, Arizona. Nearly 15,000 photographs have been made since 1924 on the program of Milky Way variable stars—a research designed to give information on the structure and dimensions of the galactic system. The survey of the photographic brightness of the stars is to extend to magnitude 8.5, and includes approximately 120,000 stars over the whole sky; the photographs are made at Cambridge and at Bloemfontein, and are measured with the thermo-electric microphotometer. An extensive program on the motions of the nearby stars is carried on in cooperation with the University of Minnesota. Investigations dealing with the variable stars that have been selected for international cooperation are carried on in conjunction with the University of Missouri, Hood College, Cornell University, the Case School of Applied Science, Connecticut College, and several other institutions. The photographs are made at Harvard and measured at the other observatories. Only nine meteor spectra are now known—three on Harvard plates, three on Moscow plates, two from Mount Wilson and one from Hamburg. In the Harvard collection only about one spectrum plate in 20,000 shows spectra of meteors, but with special cameras it is hoped to get one spectrum out of every fifty to a hundred attempts. In the systematic sky patrol approximately 90,000 photographs have been accumulated—all on glass negatives, 8 x 10 inches in size. These plates form the basis of numerous investigations of variable stars and stellar distribution. Cooperative programs dealing with the structure of the stellar universe are carried on in conjunction with the astronomical departments of Amsterdam and Groningen; for the Groningen work the photographs are taken on specially made plate glass plates. Other active researches at the Harvard Observatory deal with the discovery and measurement of extragalactic nebulae, and with the less remote globular clusters, and the Magellanic Clouds. The classification of the spectra of faint stars in interesting regions is a special problem of the highest importance. A number of special photometric programs, including the determination of standard photographic sequences and the establishment of systems of photovisual and red magnitudes, are also in active operation.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BUSINESS PROCEEDINGS OF THE EXECUTIVE COMMITTEE

THE executive committee of the council of the American Association for the Advancement of Science met on Saturday, April 23, and Sunday, April 24, in Washington, D. C. Since the executive committee acts for the council when it is not in session, the following items of business transacted are to be interpreted as actions of the council:

1. The Genetics Society of America and the American Sociological Society were accepted as affiliated societies.

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[3] Director of the Yale University Observatory.

2. The defunct American Federation of Teachers of the Mathematical and Natural Sciences and the Botanists of the Central States were dropped from the list of affiliated societies.

3. A constitutional amendment to permit each division to name two council representatives was ordered brought before the council at Atlantic City.

4. The proposal that the association cooperate with Sigma Xi in commemorating the fiftieth anniversary of its founding at Cornell University was discussed and the permanent secretary was asked to secure from the society possible alternatives for such cooperation for consideration at the next meeting of the Executive Committee.

5. The resignation of Dr. A. G. McCall as auditor was accepted and Dr. W. J. Humphreys was elected auditor.

6. The executive assistant was authorized to sign checks drawn against the checking account No. 1 of the Association in the American Security and Trust Company. In the absence or inability of the executive assistant the checks are to be signed by the permanent secretary. A joint bond of $20,000 to cover the responsibility of the executive assistant and the permanent secretary was ordered.

7. $15,000 now in the reserve funds of the office of the permanent secretary were ordered transferred to the treasurer for investment in such a manner as to remain subject to the order of the officers of the association. The permanent secretary was authorized to invest $5,000 in U. S. Treasury Certificates, purchase to be made from reserve funds of the office of the permanent secretary. The balance of the permanent secretary's reserve funds were ordered deposited in savings accounts of two Washington banks.

8. A report on the Hector Maiben bequest from Mr. Wm. G. Long, Seattle attorney, was accepted. It was reported that the appraised value of the estate, fixed by the court, amounted to $37,833.40. Inheritance tax and administration fees will be deducted from this amount. An honorarium of $150 was voted for Mr. Wm. G. Long in appreciation of his services, this sum to be paid from the treasurer's current funds. Mr. Ben Maiben, brother of Hector Maiben, was appointed as the association's local representative in Nebraska with authority to act in all cases where problems or exigencies may arise in connection with securities on property in Nebraska obtained through the will of his brother.

9. In memory of Hector Maiben, a Hector Maiben lecture to be given each year at the annual (winter) meeting of the association was established. This lecture will carry an honorarium of $200 and traveling expenses for the lecturer. The first Maiben lecture will be held at Atlantic City.

10. The expenses of the secretary of the academy conference in attending the annual meeting were authorized to be paid on the same basis as expenses of section secretaries.

11. It was voted that members of the executive committee attending the meetings of the committee at Syracuse will be expected to pay their own expenses.

12. It was voted to pay expenses of only those section secretaries who take an active part in arranging programs for the Syracuse meeting.

13. A new half year membership at one half the regular annual dues was authorized for those joining the association between April 1 and October 1. Such new members will receive a journal subscription for the six months beginning July 1. Members joining under this plan will be billed for a regular year's membership at the time of the October billing.

14. An additional appropriation of $649.12 was made to cover over-expenditures of the Science Exhibition committee at New Orleans. Total expenditures were reported as $3,149.12.

15. A letter from Dr. Otis W. Caldwell, chairman of the Committee on the Place of Science in Education, was read, recommending that the committee be discharged, and that the unexpended balance of the committee's funds be held in the association's reserves. The report was accepted and the permanent secretary was asked to confer with Dr. Caldwell.

16. The president and the chairman of the executive committee were asked to select a delegate to attend the meeting of the British Association for the Advancement of Science to be held in York, England, August 31 to September 7.

17. It was voted to hold the next fall meeting of the executive committee in Atlantic City on the third Saturday and Sunday in October.

18. The committee adjourned to meet in Syracuse on June 20.

CHARLES F. ROOS,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SHORT METHOD FOR CALCULATING MOISTURE PERCENTAGES[1]

THE determination of moisture is an essential part of many analytical procedures and the calculations involved are somewhat tedious. Careful checking is required to prevent errors. The use of a calculating machine naturally increases the speed and accuracy of the work. In connection with a large number of routine analyses, a short method of computing moisture percentages with the aid of a calculating machine was devised which may be of interest to others. This method reduces the time required since only four figures need be recorded in the machine until the moisture percentage is obtained. By any other method familiar to the author, seven to nine operations and the writing down of intermediate figures are necessary. The method can best be explained by means of an example, in which it is assumed that an 8 row, 3 dial machine is available. Minor differences in other makes and models of calculating machines, particularly, a different number of rows of keys, introduce slight modifications in technique which should be obvious to an experienced operator.

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[1] Approved for publication by the chief, U. S. Bureau of Chemistry and Soils.

Problem: What is the moisture content, on a dry weight basis, of a sample of soil, the following data having been obtained in the laboratory?

Weighing bottle + air-dry soil	32.5868 grams
Weighing bottle + oven-dry soil	32.3676 grams
Weight of empty weighing bottle	29.3306 grams

Procedure: During the operations, put all numbers on the right-hand side of the keyboard, maintaining a constant position for the decimal point. Move the pointers over the dials to the positions shown by the arrows in order to indicate the position of the decimal point during the operations. Move the carriage as far as it will go toward the right and put the weight of the bottle plus air-dry soil in the carriage dial. The dials then appear as follows:

```
       ↓                 ↓
0 0 3 2 5 8 6 8     1 0 0 0 0 0 0 0
             ↓             ↓
    0 0 0 3 2 5 8 6 8 0 0 0 0 0 0 0
```

Next move the carriage as far as it will go toward the *left* and put the weight of the bottle plus oven-dry sample on the *right* side of the carriage dial:

```
       ↓                 ↓
0 0 3 2 3 6 7 6     1 0 0 0 0 0 0 1
             ↓             ↓
    0 0 0 3 2 5 8 6 8 0 3 2 3 6 7 6
```

Now put the weight of the empty weighing bottle on the keyboard and subtract it from each set of figures by sliding the carriage from one end to the other, and subtracting with the carriage at each end. The dials now show:

```
       ↓                 ↓
0 0 2 9 3 3 0 6     0 0 0 0 0 0 0 0
             ↓             ↓
    0 0 0 0 3 2 5 6 2 0 0 3 0 3 7 0
```

These figures in the carriage dial are the weights of the air-dry and oven-dry samples, respectively, and need not be noted unless desired. Clear the keyboard and put the weight of the oven-dry sample (the figures on the right-hand side of the carriage) on the keyboard and subtract from both sides as explained above. If no mistake was made in transferring the figure, the numbers on the right side of the carriage become zero, thus automatically checking the transferred number, and those on the left represent the loss in moisture of the sample. The dials at the end of this operation appear as follows:

```
       ↓                 ↓
0 0 0 3 0 3 7 0     8 9 9 9 9 9 9 9
             ↓             ↓
    0 0 0 0 0 2 1 9 2 0 0 0 0 0 0 0
```

The machine now has the weight of the moisture near the left center of the carriage dial and the weight of the oven-dry sample on the keyboard, thus it is correctly set for dividing the first by the second to obtain the percentage of moisture. Clear the *upper right-hand* dial before starting the division, which is performed in the usual manner. In the example given, the moisture content is 7.217 per cent.

This figure, plus 100.0 per cent., gives a factor by which all other analytical data, expressed in percentage of the fresh sample, can be converted to percentage on the dry-weight basis. Thus if the silica content of the soil in the preceding example is 61.54 per cent. on the basis of an air-dried sample, it is 61.54 × 1.0722, or 65.98 per cent., on the oven-dry basis.

The operation is the same for samples containing over 100 per cent. moisture, expressed on a dry-weight basis. In this case, however, the factor for converting the fresh-weight to dry-weight percentage is correspondingly large. For example, if the dry-basis nitrogen percentage of a sample of soy-beans is desired and the moisture and nitrogen determinations of the fresh material gave the following data,

Weighing bottle + fresh plant	45.2768 grams
Weighing bottle + dry plant	32.9884 grams
Weight of empty weighing bottle	29.3306 grams
Nitrogen, fresh-weight basis	0.58 per cent.

the calculation of the moisture content gives 335.95 per cent. on a dry-weight basis and the conversion factor is therefore

$$3.3595 + 1.0000 = 4.3595,$$

hence the nitrogen content on the dry-weight basis is

$$.58 \times 4.3595 = 2.53 \text{ per cent.}$$

With the increasing dependence upon machine calculation, simplified methods similar to this have probably been devised by other investigators, although a limited search of the literature has failed to disclose published references. Therefore the above method is offered to those who may be interested in a simple, rapid and accurate procedure for handling moisture calculations.

Nelson McKaig, Jr.
Bureau of Chemistry and Soils,
U. S. Dept. of Agriculture,
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A BALANCE FOR LIVE ANIMALS

Certain experiments in this laboratory have necessitated recording every week the weight of large numbers of rats. A spring balance was found to be unsatisfactory for two reasons, it does not read correctly over a range of 0 to 400 grams, and the movements of a rat on the pan cause such wide oscillations of the pointer that accurate reading is impossible. An ordinary beam balance has the additional disadvantages of being slow in operation because of the time required to manipulate weights, and of being even more affected than the spring balance by the movements of the rat.

The addition of a simple attachment to a commercial direct-reading beam balance gave such satisfactory results that we believe other workers may be glad to have a description of the device. The balance is one of those commercial balances of 1 kilo capacity, reading directly from 0 to 100 grams in one gram intervals, in which the oscillations of the beam are damped by a paddle attachment immersed in oil. Such a balance is most useful for general laboratory purposes, and even for weighing animals. Its performance may be considerably improved, however, by additional damping to overcome the oscillations caused by movements of the animal on the scale pan. We have achieved this by attaching to the underside of the scale-pan a paddle immersed in oil. This successfully damps the sideways or rotatory oscillations. A cup-shaped pan was adopted because rats move about in it very much less than on the ordinary scale-pan. The oscillations of the pointer due to movements of a rat are in this way practically eliminated.

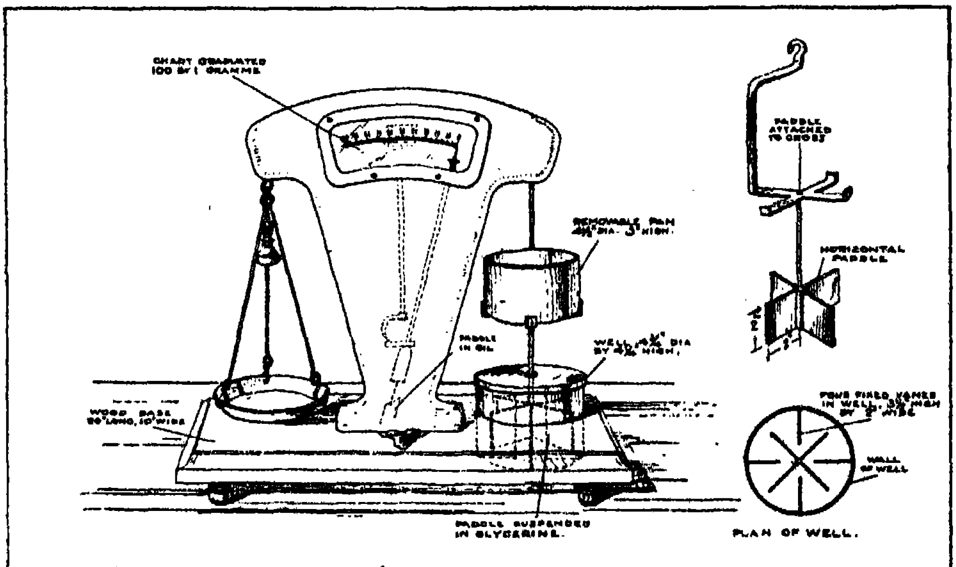
CHART GRADUATED 100 BY 1 GRAMME
PADDLE ATTACHED TO CROSS
REMOVABLE PAN DIA. 3" HIGH.
HORIZONTAL PADDLE
PADDLE IN OIL
WELL DIA BY HIGH.
WOOD BASE 20" LONG, 10" WIDE
FOUR FIXED VANES IN WELL HIGH BY 2" WIDE
WALL OF WELL
PADDLE SUSPENDED IN GLYCERINE.
PLAN OF WELL.

SCALE FOR WEIGHING LIVE ANIMALS.

As many as three hundred weighings of rats, accurate to within 1 gram, may, with this apparatus, be made easily in one hour.

Messrs. W. and T. Avery, of Toronto, who are the makers of the commercial balance which we have adapted, were good enough to construct the additional attachments for us.

Bruce F. Crocker
Hardolph Wasteneys
Department of Biochemistry,
University of Toronto

SPECIAL ARTICLES

THE CHEMICAL STUDY OF INSULIN[1]

Crystalline insulin was first prepared by Abel in 1926.[2] Since then it has been of the greatest interest to ascertain the chemical structure of this substance, which plays so important a rôle in carbohydrate metabolism. It was found that crystalline insulin was of characteristic protein nature, possessing a high sulfur content of 3.2 per cent.[3] Naturally, the question arises whether this crystalline protein is identical with the hormone itself, possessing therefore its specific hypoglycemic action, or whether the protein crystal acts simply as a convenient carrier, the true hormone being adsorbed or loosely bound to the protein surface. The assumption that the crystalline protein is the hormone itself is based upon the following evidence.

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[1] No. 13 of the series "Studies on Crystalline Insulin." Investigations carried out under grants from the Carnegie Corporation of New York and the Eli Lilly Company, Indianapolis, Indiana.

[2] J. J. Abel, *Proc. Nat. Acad. Sci.*, 12, No. 2, 132, 1926; Abel, Geiling, Rouiller, Bell and Wintersteiner, *J. Pharmacol. and Exp. Therap.*, 31, 65, 1926.

Crystalline insulin possesses the maximal amount of physiological activity thus far obtained from insulin preparations, namely, 24 international units per milligram.[4] Attempts to obtain more active products have failed.[5] The preparation, as claimed by Dingemanse,[6] of an amorphous substance four times as potent as crystalline insulin, but extremely unstable, could not be repeated by workers in other laboratories[7] so that further proof is necessary before this can be generally accepted. The physiological activity of the crystals is independent of the method of their preparation[8] and also of the source of the pancreatic tissue from which they are obtained. Crystalline insulin has been prepared from the islet tissue of certain fishes[9] and from pig and sheep pancreas.[10] Insulin crystals obtained from these various sources all possess the same activity, approximately 24 units per milligram, and all have the same sulfur content, 3.2 per cent.[11] All the evidence thus far obtained favors the assumption that this crystalline protein represents the hormone insulin in its purest and most active form.

It may be added here that the ease with which one can obtain crystalline insulin varies, as does the yield, with the commercial product used for its preparation.[12] Using the proper preparation (in this laboratory Squibb's commercial product has given the best yield) satisfactory amounts of crystalline insulin can be obtained. In contradiction to a statement in *Nature*[13] the yield of crystalline insulin in terms of activity is about 50 per cent., using the Squibb's commercial material. It has been shown in this laboratory that the initial hyperglycemia produced by commercial insulin preparations is a non-hormonic action due to the impure nature of these preparations.[14]

It is of fundamental importance to decide whether the activity of insulin is a function of the whole molecule or of a prosthetic group, non-proteid in composition, which is attached to the protein complex. The latter situation exists in the case of hemoglobin, in which globin is the protein component and hematin (an iron-pyrrole compound) constitutes the prosthetic group. However, hematin, which is easily separable from the original molecule, is incapable of assuming the function of hemoglobin in the blood. In the case of crystalline insulin efforts to show the presence of such a prosthetic group, chemically different in its composition from ordinary amino acids, have thus far failed. As yet there is no evidence that such a constituent is present in the crystalline protein.

If one does not assume that the insulin molecule as a whole is responsible for the physiological action another possibility demands consideration. A grouping of certain component amino acids embedded in the molecule may be responsible for the hypoglycemic effect of insulin. In the case of the thyroid protein, iodothyreoglobulin, the physiological activity is a property, not of the protein as a whole, but of a specific constituent, thyroxine, which, moreover, is readily separable from the rest of the molecule.[15] Various attempts to separate such an active component from the insulin molecule have resulted in inactivation. The possibility exists, of course, that an active intramolecular complex, if present, is so unstable that it decomposes as rapidly as it is liberated. Investigation of the intact insulin molecule, therefore, would be necessary to establish the presence of a similar component. Could one definitely assign specific physiological activity to such a group, it is still possible that this constituent, when isolated from the molecule as a whole, would not show all the specific physiological actions of insulin.

The investigation of the possible existence of such groupings in the insulin molecule may be approached in two ways, first, one may separate and characterize the different amino acids obtained by hydrolysis. This method in addition will allow the identification of any constituents in the molecule other than amino acids. Secondly, one might also establish the presence of physiologically active groups by treating insulin with chemical reagents having a precise action on certain specific arrangements in the molecule. Investigation of the insulin molecule by these two methods has been in progress in this laboratory since the crystallization of insulin. The expensive nature of the material makes it imperative to use only small quantities for chemical manipulation. In conjunction with the time-consuming assay of the products of chemical treatment this has made progress somewhat slow.

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[3] Abel, Geiling, Rouiller, Bell and Wintersteiner, *J. Pharmacol. and Exp. Therap.*, 31, 65, 1926.

[4] Jensen, Wintersteiner and Geiling, *J. Pharmacol. and Exp. Therap.*, 36, 115, 1929.; Freudenberg and Dirscherl, *Zeit. physiol. Chem.* 180, 212, 1929; Harington and Scott, *Biochem. J.*, 23, 384, 1929.

[5] duVigneaud, Geiling and Eddy, *J. Pharmacol. and Exp. Therap.*, 36, 125, 1929; Jensen and DeLawder, *J. Biol. Chem.*, 87, 701, 1930.

[6] Dingemanse: *Arch. néerl. physiol.*, 12, 259, 1927; van Bronkhurst, *Pharmaceutisch weekblad*, 26, 641, 1930.

[7] See reference 5 and Dirscherl, *Zeit. physiol. Chem.*, 202, 116, 1931.

[8] Harington and Scott, *Biochem. J.*, 23, 384, 1929.

[9] Jensen, Wintersteiner and Geiling, *J. Pharmacol. and Exp. Therap.*, 36, 115, 1929.

[10] Scott, *J. Biol. Chem.*, 92, 281, 1931.

[11] See references 9 and 10.

[12] Jensen, Wintersteiner and Geiling, *J. Pharmacol. and Exp. Therap.*, 36, 115, 1929; Jensen and DeLawder, *Zeit. physiol. Chem.*, 190, 262, 1930.

[13] *Nature*, 126, 910, 1930.

[14] Geiling and DeLawder, *J. Pharmacol. and Exp. Therap.*, 39, 369, 1930.

[15] See reference 8.

Earlier publications from this laboratory have shown the presence of the following amino acids in the insulin molecule: cystine, about 12 per cent.; tyrosine, about 12 per cent.[16]; and arginine, histidine, lysine and leucine.[17] These amino acids are not sufficient to account for the total nitrogen of insulin. Determination of the distribution of nitrogen in the crystalline protein also indicates the presence of amino acids other than those listed above. In cooperation with Dr. Wintersteiner at Columbia University, New York, I have therefore undertaken anew the hydrolysis of insulin with somewhat larger amounts (4 grams). Only workers in this field will realize the difficulties of isolating various amino acids from such a small amount of original material. One can only hope for a renewed study of the chemical properties and quantitative separation of the various amino acids. Such a research would prove invaluable, not only in the study of insulin, but also for the chemical investigation of other biologically important compounds, protein in nature, and available only in comparatively small amounts.

The new hydrolysis of insulin reveals that the protein is composed of relatively few amino acids. Besides those already mentioned glutamic acid has been isolated and identified.[18] According to the amount of ammonia nitrogen (9.58 per cent. of total nitrogen) found in the determination of the nitrogen distribution in insulin,[19] a comparatively large amount of this amino acid should be present. Evidence of the presence of hydroxyvaline has also been obtained and, furthermore, leucine was found to be present in relatively large amounts. The presence of proline seems doubtful. No evidence for the presence of any other amino acids, or of any other constituent differing in its composition from an amino acid, could be obtained. We, therefore, find the following amino acids in the insulin molecule: cystine, tyrosine, glutamic acid and leucine, each present in quantities of more than 10 per cent.; and histidine, arginine, lysine, hydroxyvaline and proline (the last two are doubtful) in smaller amounts. The details of our work on the hydrolysis of insulin will be published elsewhere.[20]

The problem of linking the physiological activity of insulin to certain amino acid groups has been approached in two ways. First, various derivatives of insulin were prepared and their activity studied. The fundamental idea underlying these experiments was to block the active group or groups and thus to obtain a compound of no or greatly diminished activity. Then, by splitting off the radical which had been introduced into the active group, one might obtain a product, either equally as active as the original crystalline insulin, or at least of higher activity than the unhydrolyzed "blocked" substance. In undertaking these experiments one must bear in mind the marked instability of insulin. By treating insulin with acetic anhydride, acetyl insulin is obtained either with greatly diminished activity[21] or in a completely inactive form.[22] Hydrolysis of the acetyl insulin gives a product of an activity higher than that of the acetylated compound but lower than that of the original insulin. Under the conditions employed acetylation is possible at $-OH$, $-NH_2$ and $=NH$ groups. It is logical to conclude, therefore, that the acetylated group or groups are of importance in the physiological action of insulin.

The treatment of insulin in weakly alkaline solution with benzaldehyde and other aldehydes yields completely inactive products. Reactivation of these compounds has thus far been unsuccessful.[23] Here again one may conclude that the active group or groups have been blocked.

Insulin, when allowed to stand in acid alcohol for several hours, gives a completely inactive product. On treatment of this compound with very dilute alkali, about 60 per cent. of the activity is regained.[24] The hydrolyzed product may be partly obtained again in crystalline form identical with the original crystalline insulin.[25] Various investigators ascribe the inactivation to the blocking of the active group or groups by methylation (using methyl alcohol) of the $-OH$, $-NH_2$ and $=NH$ group or to the esterification of the $-COOH$ group. Treatment with dilute alkali removes the methyl radical with the subsequent regeneration of the active groups. Later in this paper I shall propose a further explanation for this reaction.

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[16] duVigneaud, Jensen and Wintersteiner, *J. Pharmacol. and Exp. Therap.*, 32, 367, 1928.

[17] Jensen, Wintersteiner and duVigneaud, *J. Pharmacol. and Exp. Therap.*, 32, 387, 1928.

[18] Jensen, *J. Biol. Chem.* (in press).

[19] Wintersteiner, duVigneaud and Jensen, *J. Pharmacol. and Exp. Therap.*, 32, 397, 1928.

[20] Jensen and Wintersteiner, *J. Biol. Chem.* (in press).

[21] Jensen and Geiling, *J. Pharmacol. and Exp. Therap.*, 33, 511, 1928; Freudenberg and Dirscherl, *Zeit. physiol. Chem.*, 175, 1, 1928; Freudenberg, Dirscherl and Eyer, *Zeit. physiol. Chem.*, 187, 95, 1930; Jensen and DeLawder, *Zeit. physiol. Chem.*, 190, 262, 1930.

[22] Charles and Scott, *Trans.* Royal Soc. Canada, Section v, 187, 1931.

[23] Jensen and DeLawder, *Zeit. physiol. Chem.*, 190, 262, 1930; Freudenberg, Dirscherl and Eyer, *Zeit. physiol. Chem.*, 202, 144, 1931.

[24] Carr, Culhane, Fuller and Underhill, *Biochem. J.*, 23, 1010, 1929; Charles and Scott, *J. Biol. Chem.*, 92, 289, 1931; Freudenberg, Dirscherl, Eyer, *Zeit. physiol. Chem.*, 202, 133, 1931.

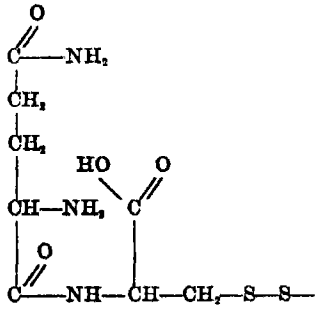
[25] Charles and Scott, *J. Biol. Chem.*, 92, 289, 1931.

The reduction of insulin, even under the mildest conditions, gives an inactive product which thus far has been found incapable of reactivation. Under the conditions employed probably only the disulfide linkage is affected. Since insulin gives no positive test for the sulfhydryl group it is generally assumed that all the sulfur is present as the disulfide linkage. In my opinion the total sulfur of insulin exists as cystine in the molecule. Even such mild reducing agents as cysteine and glutathione will apparently reduce the disulfide linkage, giving a physiologically inactive product which can not be reactivated.[26] It has been found that under mild conditions initial inactivation coincides with the first appearance of a positive sodium nitroprusside test for the sulfhydryl group.[27] In the above experiments the inactivation of insulin resulted from the alteration of certain physiologically important groups, without, however, removing these groups from the original molecule.

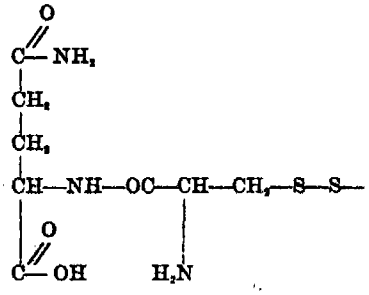
A second line of attack consists in splitting off such active groups and then determining the particular amino acid affected by this treatment. If insulin is heated with N/10 hydrochloric acid in a boiling water bath, an inactive coagulum is obtained. Treatment of this coagulum with dilute alkali gives a product, the activity of which is practically equal to that of crystalline insulin.[28] In spite of its high activity, efforts to recrystallize this material by the usual method have failed.[29] duVigneaud and coworkers[26] express the view that the formation of a coagulum under these conditions is specific for insulin and that the physiologically important groups are involved in this reaction. I shall return to this reaction later. It has also been pointed out in earlier communications from this laboratory that insulin, under the influence of alkali, not only splits off sulfur,[30] but also ammonia.[31] A later and more detailed study of this reaction[32] indicates that treatment of insulin even with very dilute alkali liberates ammonia and leads to the formation of an inactive product. There seems to exist a correlation between the degree of inactivation and the amount of ammonia given off. Under these same conditions the sulfur of insulin is also affected. Thus far it has not been possible to inactivate insulin irreversibly without removing at least a part of its sulfur, and it may be doubted whether one can remove a part of the sulfur without affecting the activity. In opposition to this point of view Freudenberg and his coworkers[33] assume that the sulfur of the insulin molecule plays no rôle in the action of its active component. If one affects only a very small part of the sulfur, as in Freudenberg's experiment, the unfortunate variations of the physiological assay may prevent the clear indication of the resultant slight inactivation. This point is under a more thorough investigation in this laboratory at the present time.

These experimental findings, in conjunction with others omitted because of their detailed nature, have led me to postulate the characteristic constituent of the insulin molecule as composed, wholly or in part, of glutamic acid and cystine and having the following chemical structures:

Formula I



Formula II



I am quite aware that I am unable at the present time to furnish exact proof that the glutamic acid is linked to cystine as indicated in the above formulae. These structures are proposed only as a working hypothesis on which to base further efforts toward the elucidation of a possible specific constituent of insulin.

---

[26] duVigneaud, Fitch, Pekarek and Lockwood, *J. Biol. Chem.*, 94, 233, 1931.

[27] Unpublished results.

[28] duVigneaud, Geiling and Eddy, *J. Pharmacol. and Exp. Therap.*, 33, 497, 1928; Freudenberg and Coworkers, *Zeit. physiol. Chem.*, 180, 228, 1929; 187, 91, 1930; 202, 131, 1931.

[29] Jensen and DeLawder, *Zeit. physiol. Chem.*, 190, 262, 1930.

[30] Abel and Geiling, *J. Pharmacol. and Exp. Therap.*, 25, 423, 1925.

[31] Jensen, Wintersteiner and duVigneaud, *J. Pharmacol. and Exp. Therap.*, 32, 388, 1928; Wintersteiner, duVigneaud and Jensen, *J. Pharmacol. and Exp. Therap.*, 32, 410, 1928.

[32] Jensen and DeLawder, *Zeit. physiol. Chem.*, 190, 270, 1930; Freudenberg, Dirscherl and Eyer, *Zeit. physiol. Chem.*, 187, 192, 1930; 202, 129, 1931.

[33] Freudenberg, Dirscherl and Eyer, *Zeit. physiol. Chem.*, 187, 100, 1930.

The action of acids and alkali on insulin to which I have already referred has been studied in more detail by E. A. Evans, Jr., and myself. The results thus far obtained seem to support the postulation of the above grouping in the insulin molecule. Insulin, when heated with N/10 hydrochloric acid in a boiling water bath forms a coagulum with the simultaneous appearance of ammonia. Upon redissolving this precipitate in very dilute alkali and again subjecting the material to the original acidity and temperature, a second coagulum is obtained with the separation of much less ammonia than before. The formation of this acid insoluble coagulum indicates a decrease in the basicity of the protein molecule, such as would result, in the case of the postulated grouping (formula I), from the condensation of the amide group and the amino group with the elimination of ammonia. Solution of this condensation product in alkali would open the lactam ring with the regeneration of the carboxyl group. In case of formula II the ammonia is derived from the amide group, and the condensation of the amino group with the free carboxyl group, giving a diketopiperazine, accounts for the formation of a coagulum. Alkaline treatment of the insulin acid coagulum results in regaining practically the complete physiological activity of crystalline insulin. In terms of the postulated structures, however, this material should differ from the original insulin in the number of free carboxyl groups present, due to the removal of the amide group. This may explain the failure to crystallize this alkali-treated material by the usual method. If these assumptions are correct, the removal of the free amino group should prevent the formation of an acid insoluble coagulum. The treatment of insulin with very dilute alkali splits off ammonia and gives a product which does not coagulate when heated with N/10 hydrochloric acid at 100° C. This seems to point to the removal of the amino group under alkaline treatment. One may infer from these data that the amide group is not necessary for the physiological action of insulin.

Interpretation of the results of alkaline treatment of insulin is somewhat uncertain in reference to the postulated insulin constituents. One can only conclude from the study of alkali action on insulin that the sulfur, or at least a part of it, as the disulfide linkage, and also a free amino group are necessary for physiological activity. The inactive product of alkali treatment gives only a very weak ninhydrin reaction in contrast to the strongly positive test of crystalline insulin. This suggests, though the question remains unsettled, that the ammonia given off by alkaline treatment originates from the physiologically important amino group. The details of the experimental work involved in these conclusions will be published elsewhere.[34]

Reference must also be made to the following experiment. Treatment of insulin with acid alcohol produces a physiologically inactive product giving a negative ninhydrin reaction. Subjecting this material to the action of dilute alkali restores most of the activity with the simultaneous reappearance of the positive ninhydrin reaction of the original insulin. One may explain this by assuming that the carboxyl group of the cystine (formula I), or of the glutamic acid (formula II), after esterification, reacts with the free amino group to form a diketopiperazine. The resultant blocking of the free amino group accounts for the negative ninhydrin reaction. Alkaline treatment opens the diketopiperazine ring with the regeneration of the original molecule, and also of the free amino group which reacts with ninhydrin. These results are also treated in more detail elsewhere.[34]

Although these findings may be explained in terms of the postulated active constituents of insulin, further proof is necessary to establish the validity of these assumptions. It hardly needs to be said that the results can also be explained by assuming a similar combination of another amino acid, such as tyrosine or leucine, with cystine. I believe, however, that cystine is of importance and is a part of the possible active constituent. The similarity in the physiological action of insulin and glutathione suggests glutamic acid as a possible constituent of the active group. The determination of the amino acid, to which the free amino group is attached, is important. The research is being continued in this direction and the synthesis of cystine peptides having the postulated structures is also being attempted. I wish to propose this hypothesis in only the most cautious and tentative manner until further data, either supporting or opposing the postulated structures, are available.

H. Jensen

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SCIENCE

VOL. 75 FRIDAY, JUNE 17, 1932 No. 1955

Infection and Resistance in the Blood-inhabiting Protozoa: PROFESSOR WILLIAM H. TALIAFERRO 619

Obituary:
Ashe, Pioneer Forester and Botanist: WILLIAM A. DAYTON. *Recent Deaths* 629

Scientific Events:
Gifts to the British Natural History Museum; The Engineering Societies Library; Field Conference of Pennsylvania Geologists; The Neandertal Race in Palestine 630

Scientific Notes and News 632

Discussion:
Physiography and the Dynamic Cycle: PROFESSOR DOUGLAS JOHNSON. *An Appeal to Anthropologists:* DR. KNIGHT DUNLAP and W. C. BEASLEY. *A Further Note on the Analysis of Electromyograms:* PROFESSOR LEE EDWARD TRAVIS and THEODORE A. HUNTER 636

Scientific Books:
Cannon on the Wisdom of the Body: PROFESSOR GRAHAM LUSK. *Baker's The Universe Unfolding:* DR. IDA BARNEY 640

Societies and Academies:
The Iowa Academy of Science 641

Scientific Apparatus and Laboratory Methods:
A New Hydrogen Electrode and Apparatus for the Determination of pH: DR. P. LECOMTE DU NOÜY. *A Method of Relacquering the Stems of Livingston Atmometer Bulbs:* DR. JOHN STANLEY 643

Special Articles:
The Apparent Prepotent Function of the Adrenal Glands: PROFESSOR S. W. BRITTON and H. SILVETTE. *Some Effects of Ovariectomy upon Breeding Females:* DR. WILLIAM S. MURRAY. *Growing Cotton and Other Crop Plants with Ammonium Nitrogen:* VICTOR A. TIEDJENS 644

Science News 6

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INFECTION AND RESISTANCE IN THE BLOOD-INHABITING PROTOZOA[1]

By WILLIAM H. TALIAFERRO

PROFESSOR OF PARASITOLOGY AND ASSOCIATE DEAN OF THE DIVISION OF BIOLOGICAL SCIENCES, UNIVERSITY OF CHICAGO

CERTAIN of the blood protozoa, because of their size and easily accessible location, offer unique opportunities for the study of the effects of acquired resistance on the parasites and of the humoral and cellular bases for these effects. This evening I propose to discuss two of these in detail, *Trypanosoma lewisi* of the rat and *Plasmodium cathemerium* of the bird, and to consider a few others comparatively. Specifically, I plan to describe the normal course of infection, to analyze the effects of the host's resistance on the parasites, to describe the antibody bases for some of these effects and to correlate the antibody and other immune responses with the cellular reactions of the host. I sincerely hope that these facts will be of intrinsic interest to you and in addition that they will illustrate the methodology which we have found successful in our immunological studies of protozoan infections. But, above all, I hope that the facts will bring out the peculiar advantages of these protozoa as material for certain immunological problems.

The fundamental methods which we have used in analyzing the effects of resistance will become apparent in the discussion of the specific infections. A few words should be said, however, regarding the method of reproduction in the blood protozoa and the meaning of changes in numbers of the protozoa throughout the course of an infection. Among the trypanosomes reproduction is practically limited to binary fission. In malaria it involves schizogony, which is essentially a series of binary fissions of the nucleus followed by a terminal splitting of the cytoplasm. The organisms in both of these infections are limited to and are distributed throughout the blood stream. Therefore, if no factor or factors influence either the rate of their reproduction or their survival after they are produced, they should increase in the blood uniformly according to a geometrical progression. Conversely, the daily changes in the number of organisms per cmm of blood roughly measure the sum total of the resistance developed by the host, but they do not indicate how much of the resistance is due to an inhibition of reproduction of the parasites and how much is due to a parasiticidal effect which kills the parasites after they are produced. This evening I wish to stress the fact that this inherent difficulty can be overcome by devising various methods of ascertaining the basic rate of reproduction by measures which are independent of the number of organisms killed and the further fact that different immunological mechanisms are involved in the inhibition of reproduction and in the parasiticidal effect.

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[1] Harvey Lecture delivered before the New York Academy of Medicine, December 17, 1931.

TRYPANOSOMA LEWISI

It is hardly necessary to recall to your mind that *Trypanosoma lewisi* is a non-pathogenic blood parasite of rats all over the world and is transmitted from rat to rat by various species of fleas. It is a comparatively large trypanosome (about 30 μ in length) and occurs in the peripheral blood stream without tissue localization. Thus, what is happening in an infection can be ascertained by a study of samples of the peripheral blood.

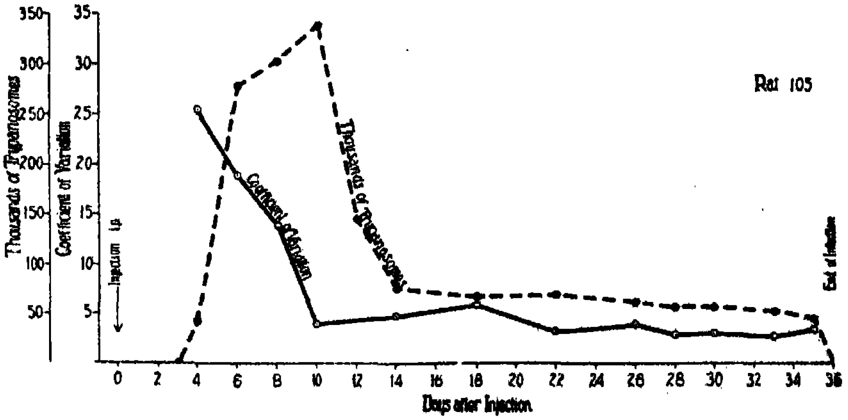

FIG. 1. Graph showing the three factors of resistance developed in a rat against an infection of *T. lewisi*. The two trypanocidal effects are represented by the two crises in the number curve and the reproduction-inhibiting effect is represented by the gradual drop in the coefficient of variation for total length of the trypanosomes. (From the author.)

Daily number counts of the trypanosomes throughout the course of an infection in the rat show that the infection progresses with certain typical features. (See review in Taliaferro, 1929.[2]) Following the injection of the parasites, unless large numbers have been injected intravenously, there is an incubation period of greater or less time during which no organisms are found in the blood. Then there is an acute rise of the infection until the trypanosomes may reach 300,000 or more per cmm. This peak generally occurs between the 8th and 14th day whereupon the organisms markedly diminish in what I have termed a number crisis. Following this disappearance of most of the parasites the infection enters a developed phase during which there may be a gradual decrease in numbers, but no marked crisis. The developed infection may last from a few days to many months. Sooner or later, however, it is terminated by the more or less abrupt disappearance of the parasites from the peripheral blood stream (Fig. 1). The fact that there is no tissue localization allows certain conclusions to be drawn from these number counts. Undoubtedly there must be a trypanocidal factor killing the trypanosomes at the time of the first number crisis and at the end of the infection to account for the decrease in numbers, since even if the rate of reproduction were reduced to zero, it could not explain an actual decrease of the trypanosomes. The question then arises as to whether in addition to this trypanocidal agent there is also a factor influencing the rate of reproduction.

A study of the parasites during the ordinary course of an infection indicates that the trypanosomes actually reproduce during only the first part of the infection. Thus, when the trypanosomes are intro-

[2] W. H. Taliaferro, "The Immunology of Parasitic Infections," New York, pp. 414, 1929.

duced into the rat they begin reproduction by active cell-division within about 48 hours, continue this reproduction at a maximum rate for several days, then at a decreasing rate for several days until approximately the 10th to 12th day of the infection they have ceased to reproduce and live in the blood stream for from a few weeks to many months simply as non-reproducing adults.

As stated in my introductory remarks this inhibition of reproduction is not demonstrated by number counts, but by methods not affected by trypanocidal factors. Two such methods have been devised. The simplest method consists of ascertaining the percentage of dividing forms found in daily blood smears. Such a procedure (Fig. 2) discloses that actual dividing trypanosomes occur until about the 8th day, that variable growth forms continue until about the 11th day and that only adult forms which are extremely uniform in size and structure and which never show any stages in the division of their organelles are found after the 11th or 12th day. This method of demonstrating the cessation of reproduction in the trypanosomes was known to the early microscopists and the results clearly depicted as early as 1899 by Rabinowitsch and Kempner,[3] by v. Wasielewski and Senn (1900),[4] and especially by Laveran and Mesnil (1901).[5] A somewhat more exact method was devised by Mrs. Taliaferro and me in 1922[6] which consists in ascertaining the coefficient of variation for the total length of the trypanosomes throughout the infection. The rationale of this method is based on the obvious fact that reproducing forms with the consequent production of small forms and growth stages are much more variable than non-reproducing adults. Thus, as can be seen in Fig. 1, when the trypanosomes were at the height of their reproductive activity, as demonstrated by microscopical examination, the coefficient of variation for their total lengths was approximately 25 per cent., whereas as they ceased to reproduce, the coefficient of variation proportionately decreased until when the parasites were non-producing adults, it shaded off to about three per cent.

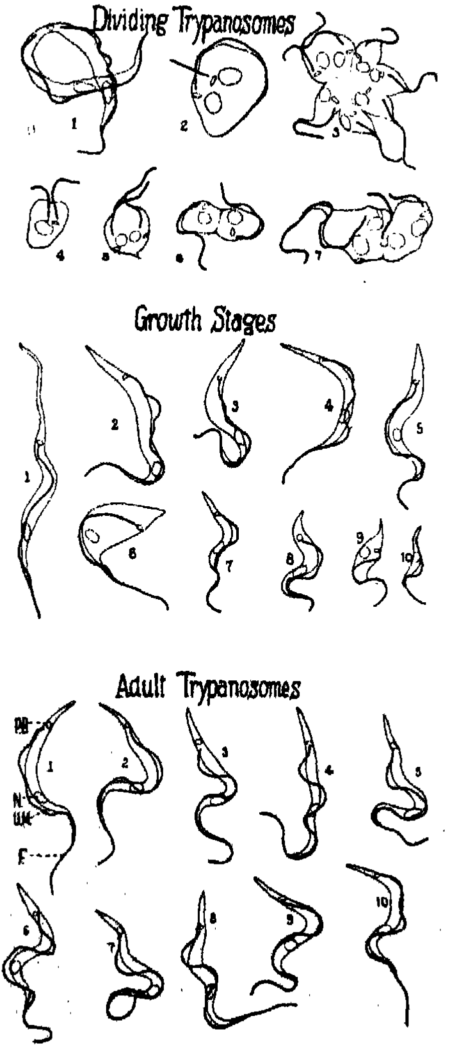

Fig. 2. Dividing, growth, and adult *T. lewisi*. The dividing and growth forms are rarely found after the tenth day of a normal infection. F., flagellum; N., nucleus; P. B., parabasal body; U. M., undulating membrane. ×1000 (Dividing forms, from Coventry; others, from the author.)

To sum up the effects of resistance on the trypanosomes, we may conclude that there is, first, some factor which completely inhibits all reproduction of the parasites by about the 10th day; second, some trypanocidal factor which kills the majority of the organisms at the time of the first number crisis (8th to 14th day); and third, a similar trypanocidal factor which terminates the infection at the end of a few days to several months.

The next step in analyzing the host's resistance to *T. lewisi* consists in demonstrating that the three effects, just outlined, are connected with definite humoral antibodies. The immunological basis for the inhibition of reproduction of the parasites was first demonstrated by the speaker in 1924[7] and was later confirmed by Coventry (1925)[8] and Regendanz and

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[3] L. Rabinowitsch and W. Kempner, *Ztschr. f. Hyg. u. Infektionskr.*, 30: 251–294, 1899.

[4] v. Wasielewski and G. Senn, *Ztschr. f. Hyg. u. Infektionskr.*, 33: 444–472, 1900.

[5] A. Laveran and F. Mesnil, *Ann. de l'Ist. Pasteur*, 15: 673–714, 1901.

[6] W. H. Taliaferro and Lucy G. Taliaferro, *Amer. Jour. Hyg.*, 2: 264–319, 1922.

[7] W. H. Taliaferro, *Jour. Exper. Med.*, 39: 171–190, 1924.

[8] Frances A. Coventry, *Amer. Jour. Hyg.*, 5: 127–144, 1925.

Kikuth (1927).[9] Briefly stated, the serum of an infected rat, in which trypanosomes have ceased to reproduce, contains a passively transferable property which will prevent adult trypanosomes from reproducing in normal rats, but which apparently does not kill them or affect their vitality. One experiment will make this clear. On the 10th day after infection (when the trypanosomes had reached the adult stage), a rat was killed and bled and its serum containing adult trypanosomes collected. Next, the trypanosomes were separated from the serum by rapid centrifugation. Then half of the adult trypanosomes together with 2 cc of the serum (per 100 gm rat) were injected into an experimental rat, while the other half of the trypanosomes together with a similar dose of normal rat serum were injected into a control rat. Daily examinations of blood smears and calculations for the coefficient of variation for total length for each of these rats showed that the trypanosomes in the experimental rat lived in the blood for 11 days (when the infection ended) without showing any reproduction whatever, whereas in the control rat reproduction began on the second day and followed the normal course. Moreover, in the experimental rat, the trypanosomes did not increase in numbers, whereas in the control rat, they increased, etc., as usual. In this experiment it is to be noted that not only did the immune rat serum (*i.e.*, the serum taken from the seed rat on the 10th day of its infection) prevent adult trypanosomes from reproducing in a test rat, but normal rat serum failed to prevent adult trypanosomes from reproducing in a control rat. Here, we have a clear-cut passive transfer of this type of immunity from an infected to an uninfected rat.

Similarly, the first number crisis is associated with a trypanocidal antibody as was first demonstrated by Coventry (1930).[10] According to her work, serum taken after the first sudden drop in numbers of parasites, was curative (*i. e.*, caused the trypanosomes to disappear) when injected into rats in which the trypanosomes had just appeared in the blood. Such serum, however, was without effect if injected after the natural number crisis. It appears, therefore, that the parasites that survive the first number crisis are either basically non-susceptible or acquire a resistance to the antibody. Since many observers have shown that whenever a trypanolysin operates on the pathogenic trypanosomes, some of them always survive, become resistant and produce a relapse, it seems not improbable that the non-pathogenic *T. Lewisi*, surviving the action of the trypanocidal antibody at the crisis, becomes similarly resistant.

There has been some difference of opinion as to the mechanism whereby the rat eliminates the trypanosomes at the end of the infection. During recent years Regendanz and Kikuth (1927)[9] concluded that it was the result of a non-specific phagocytosis by the reticulo-endothelial system. On the other hand, a large mass of evidence indicates that it is due in major part to a specific antibody. Thus, as early as 1899, Rabinowitsch and Kempner[3] showed that the serum of recovered rats was highly protective (*i.e.*, prevented infection), a fact which was verified and greatly extended by Laveran and Mesnil (1901).[5] The latter also were able to establish that such serum sometimes, but not invariably, was curative as well. More recently Coventry (1930)[10] demonstrated that it was invariably curative provided the stage of infection at which the serum was administered was standardized. In a reinvestigation of the whole question during the last few years I have come to the conclusion that the final disappearance of the trypanosomes is associated with a highly active trypanocidal antibody which acts by killing the organisms and kills so quickly that the anti-reproduction factor does not even have time to act and which can be demonstrated either protectively or curatively. Some of the infections in some of the rats illustrate another fact which I have emphasized before, *viz.*, that the examination of a number curve alone does not necessarily give a conclusive answer as to whether reproduction is inhibited. Thus, in one animal, the infection was held down for 8 days and yet examination of the parasites showed them to be reproducing at a normal rate. From this, we can conclude that no anti-reproductive mechanism was operative, but that some trypanocidal mechanism was active either directly as a result of the administration of the immune serum or indirectly through the stimulation of the body's defense.

Although there is little question that the trypanocidal antibody occurs, there is still lack of agreement as to whether it kills by opsonization or by lysis. Thus, Laveran and Mesnil (1901)[5] considered that the parasites were actively phagocytosed, whereas MacNeal (1904),[11] Manteufel (1909)[12] and the author (1924)[7] considered that they were lysed. Since the contention of Wells (1929)[13] and others that an opsonin and a lysin are the same seems to me well grounded, I do not believe this specific question need worry us further.

I have described in *T. Lewisi* two markedly different effects of resistance, namely, the inhibition of reproduction and their destruction and have ascribed their action to antibodies. The question arises: Are these antibodies identical? After some seven years' study, I (in press)[14] now feel that they are essentially different. Both antibodies show the following similar characteristics. Both are associated with the activity of the spleen and other locations rich in reticulo-endothelial cells: both are precipitated with the globulin fractions of the serum: both appear in suitable animals after immunization with killed *T. lewisi:* both are specific for *T. lewisi;* and both arise as a result of infection of an animal with *T. lewisi.* They exhibit the following differences. The reproduction-inhibiting antibody inhibits cell-division, but does not kill the parasites or induce them to become resistant, and it shows no persistent union with the trypanosomes *in vitro* so that neither is the property absorbed by the trypanosomes nor are the tryponasomes sensitized against reproduction as tested by washing them free of the serum and injecting them into normal rats.

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[9] P. Regendanz and W. Kikuth, *Centrabl. f. Bakt.*, Orig., 103: 271–279, 1927.

[10] Frances A. Coventry, *Amer. Jour. Hyg.*, 12: 366–380, 1930.

[11] W. J. MacNeal, *Jour. Infect. Dis.*, 1: 517–543, 1904.

[12] Manteufel. *Arb. a. d. k. Gesundh.*, 33: 46–83, 1909.

[13] H. G. Wells, "The Chemical Aspects of Immunity." 2nd. New York, pp. 286, 1929.

The lack of *in vitro* affinity between the reproduction-inhibiting antibody and the specific antigen, *i. e., T. lewisi,* is particularly interesting and should be emphasized. It is comparatively easy to show the *in vitro* affinity of *T. lewisi* for its specific trypanocidal antibody. Thus, in a typical experiment, serum, which was obtained after the natural termination of the infection, when tested *in vivo* was trypanocidal in curative experiments in doses of 1.0 cc to 4.0 cc per 100 grams rat and in protective experiments in doses of 2.0 cc to 5.0 cc. After absorption with dividing and adult trypanosomes—about 1,000,000 trypanosomes per cmm—there was no trypanocidal action in curative experiments in doses as high as 4.0 cc nor in protective experiments with one exception, in doses as high as 6.0 cc. The trypanosomes used for this absorption were highly sensitized so that they lived only a few minutes when introduced intravenously into a normal rat. In marked contrast to this, reproduction-inhibiting serum (*i. e.,* serum taken after the inhibition of reproduction, but before the termination of the infection) when tested *in vivo* elicited inhibition of reproduction of trypanosomes in doses of 1.5 cc to 4.0 cc per 100 grams rat, whereas after absorption with dividing trypanosomes its titer was exactly the same. Similar results were obtained when the serum was absorbed with adult trypanosomes and with both adult and dividing trypanosomes. Furthermore, the trypanosomes used in attempting to absorb the serum were not sensitized against reproduction because when injected into normal rats they underwent their usual cycle of reproduction. The objection might be raised that sufficient trypanosomes had not been used. Two facts militate against such an objection. In the first place, if too few were used those that were used would have been very highly sensitized by the antibody. But they were not. In the second place, I have found it possible to take serum after the termination of the infection which contains both the trypanocidal and the reproduction-inhibiting antibody and by absorption to remove the one and leave the other. In the light of this work and in the interest of a more concise terminology I[14] have just recently designated the principle in serum which inhibits cell-division of organisms but does not kill them as *ablastin,* from the Greek *blastos,* a sprout, germ, offspring and *ablastos,* not budding, barren, etc. Parenthetically I may add that I have always favored the unitarian hypothesis that the various serological manifestations exclusive of antitoxin-toxin reactions, are due to a single antibody. Although the trypanocidal antibody is undoubtedly a manifestation of this single postulated antibody, I believe, that the work just reviewed indicates that the reproduction-inhibiting antibody is essentially different.

As has been previously noted, the reproduction-inhibiting antibody or *ablastin,* is associated with the activity of the spleen and other locations rich in reticulo-endothelial cells. This fact is of inherent interest and has elicited considerable work. In 1927, Regendanz and Kikuth[9] showed that removal of the spleen of trypanosome-infected rats often caused a lengthening of the reproduction of the trypanosomes which they interpreted as following from a decrease in the formation of this specific antibody. Marmorston-Gottesman, Perla and Vorzimer,[15, 16, 17] in a series of papers published in 1930, corroborated and extended these findings. These results were somewhat complicated, however, by the fact that both groups of investigators used rats which were infected with *Bartonella muris-ratti,* although the first investigators tried to control the infection with neo-salvarsan. Infection with this organism will remain latent and unnoticed ordinarily, but will flare up with intense anemia upon any pronounced disturbance of the reticulo-endothelial system, such as splenectomy. In other words, infections with both *Bartonella* and *T. lewisi* are intimately connected with the action of the reticulo-endothelial system. Consequently, in collaboration with Cannon and Goodloe, I (1931)[18] reexamined the relationship of the spleen and the general macrophage system to the formation of the reproduction-inhibiting antibody in *Bartonella*-free as well as *Bartonella*-infected rats and found that it was demonstrated by histological changes, by splenomegaly and by various experimental procedures known to affect the reticulo-endothelial system. Thus, rats infected with *T. lewisi*, but *Bartonella*-free, showed in the spleen an increased prominence of the follicles and marginal zones, and a mild hyperplasia of both red and white pulp cells. These cellular changes were not as pronounced as those found when *Bartonella* alone was present (Cannon and McClelland, 1929)[10] and were even less pronounced than when *Bartonella* was present in conjunction with *T. lewisi*. Moreover, this work demonstrated that when such things as splenectomy, *Bartonella*-infection, paratyphoid infection, India ink blockade and pregnancy occur separately in a rat infected with *T. lewisi*, the reproductive cycle of the trypanosomes is not materially influenced, but that when two or more occur in conjunction with *T. lewisi* in the same rat, the reproductive activity of the trypanosomes is often profoundly altered. To illustrate—in one rat which was infected with *Bartonella* the trypanosomes underwent their usual cessation of reproduction in the initial infection, but when splenectomy was performed, an intense relapse of reproduction became evident within three days after the operation and during the later stages of pregnancy, a similar relapse occurred.

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[14] W. H. Taliaferro, *Amer. Jour. Hyg.* (in press), 1932.

[15] J. Marmorston-Gottesman, D. Perla and J. Vorzimer, *Jour. Exp. Med.,* 52: 587–600, 1930.

[16] J. Marmorston-Gottesman and D. Perla, *Jour. Exp. Med.,* 52: 121–129, 1930.

[17] D. Perla and J. Marmorston-Gottesman, *Jour. Exp. Med.,* 52: 601–616, 1930.

[18] W. H. Taliaferro, P. R. Cannon and Sara Goodloe, *Amer. Jour. Hyg.,* 14: 1–37, 1931.

Taken as a whole, this work indicates that the macrophage system in rats infected with *T. lewisi* but otherwise healthy has an effective functional level so that by the 8th to the 12th day of the infection all reproduction of the trypanosomes is inhibited and continues to be inhibited throughout the remainder of the infection, that this functional level is lowered in a cumulative way by splenectomy, *Bartonella*-infection, paratyphoid infection, India ink blockade and pregnancy, so that any one alone produces no significant derangement, but two or more in combination elicit profound disturbances in a high percentage of rats.

A similar relationship between the reticulo-endothelial system and the trypanocidal antibody in *T. lewisi* can be demonstrated, but I have stressed the relationship between the reticulo-endothelial system and the reproduction-inhibiting antibody because it is so clear-cut and gives such a unique tool for the study of the reticulo-endothelial system, not only in connection with its relation to immune phenomena, but also in establishing its connection with various general metabolic processes. Thus, we hope to infect rats with trypanosomes, wait until their reproduction has ceased and then subject them to various physiological disturbances, such as dietary insufficiencies, hormone administration, fatigue and numerous other factors to see if the trypanosomes reinitiate reproduction. If they do, we feel that we are justified in concluding a direct interrelationship of such physiological factors and the reticulo-endothelial system.

I shall not consider other species of trypanosomes in detail, but certain comparative facts should be brought out. In no case so far studied is the reproduction-inhibiting antibody or ablastin formed in infections with the pathogenic trypanosomes.[2, 6] In fact, that appears to be the outstanding difference between the two groups. Thus, when *T. brucei*, *T. gambiense*, *T. rhodesiense*, *T. equiperdum* and related forms are grown in mice there is no evidence of the action of either trypanocidal or reproduction-inhibiting factors. When the same forms are grown in the guinea-pig no reproduction-inhibiting factor is operative, but periodic trypanolysins are liberated in the blood and are associated with decreases of the parasites. Much the same probably holds for sleeping sickness in man. These trypanolysins are not permanently effective, however, because as a rule all of the trypanosomes are not killed and the survivors become resistant to the antibody. Being resistant and having their basic rate of reproduction unchanged, they repopulate the blood stream in one or more relapses until the animal succumbs.

Ablastin undoubtedly plays an important part in the prevention of relapses. Thus, during the first part of the infection with *T. lewisi*, the reproduction of the parasites is first reduced to zero. Therefore, when a trypanocidal factor appears it permanently reduces the parasites in the blood because those that remain can not reproduce, and hence can not reaccumulate or produce a relapse, as they do in the pathogenic infections. Similar antibodies occur in a group of non-pathogenic trypanosomes closely related to *T. lewisi*, but have not been found in a number of other infections which we have studied.

PLASMODIUM CATHEMERIUM

As a second infection to consider in detail, I have selected the frequently non-lethal malarial parasite, *Plasmodium cathemerium*, of the sparrow which can be experimentally studied in the canary. In this infection, unlike infection with *T. lewisi*, only a parasiticidal type of resistance is developed and furthermore, no intermediate action through a humoral antibody has been demonstrated, although the parasiticidal mechanism is again associated with the macrophage system in what Gay (1931)[20] has aptly referred to as a "pure histologic immunity."

The peculiar synchronous method of reproduction

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[10] P. R. Cannon and P. H. McClelland, *Arch. Path. and Lab. Med.*, 7: 787–800, 1929.

[20] F. P. Gay, *Jour. Amer. Med. Ass.*, 97: 1193–1199, 1931.

found in the malarial parasites allows us to carry our analysis of the factors in resistance somewhat further than in the case of *T. lewisi.* I need only recall to your mind that, whereas reproduction in the trypanosomes is haphazard, in the malarial organisms it is synchronous. Thus, all the young asexual parasites (which are the typically vertebrate part of the life-history of this form) grow up and sporulate more or less simultaneously so that at any one time a preponderance of one particular stage will be found in the blood. In the case of *Plasmodium cathemerium,* according to L. G. Taliaferro (1925)[21] and others, this asexual cycle takes 24 hours. As shown in Fig. 3, the young parasites start their existence about 6 P. M., grow, undergo a series of nuclear divisions and 24 hours later break up, *i. e.,* sporulate, into about 15.5 small parasites. Thus, the mean size of random samples taken throughout the day will show this cycle inasmuch as the mean size is small when there are only merozoites and increases until it reaches a peak just before the mature schizont breaks up during sporulation. From the standpoint of our present study the length of this asexual cycle, which is the time it takes one parasite to become 15, is a direct measure of the rate of reproduction of the parasites since the parasites always segment into approximately the same number, and it is a measure which is independent of parasiticidal factors.

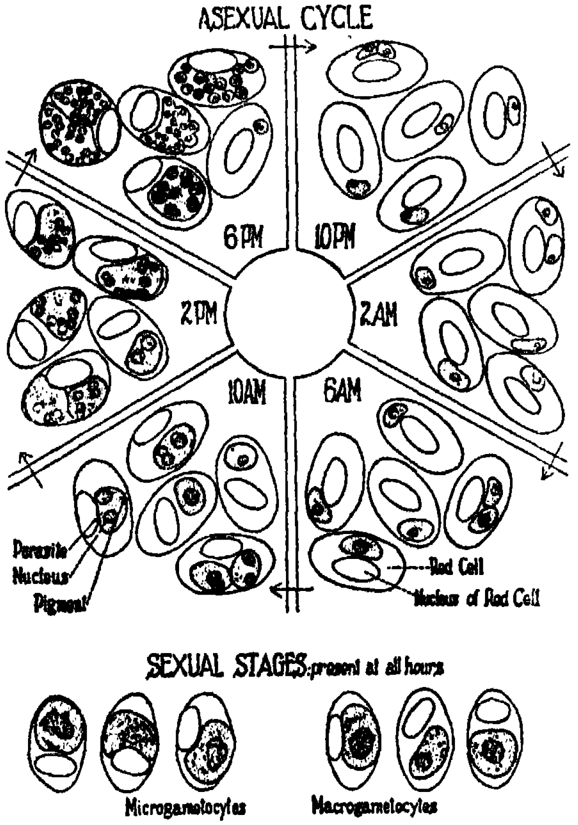

FIG. 3. Outlines of the asexual stages of *P. cathemerium* showing the synchronous method of reproduction occurring every 24 hours. ×1350. (From L. G. Taliaferro.)

Superficially the course of the infection of *P. cathemerium* in the canary is very similar to *T. lewisi* in the rat. Thus, there is an early acute rise in the number of parasites which reaches its peak between the 8th to the 15th day and which is followed in turn by a sharp number crisis, by a period of developed infection when there are comparatively few parasites in the blood, and by a latent stage which may last for as long as four years and during which there are so few organisms in the blood that they can rarely be found by microscopic examination, but can be demonstrated by injecting large amounts of blood into uninfected birds. Throughout this latent period severe relapses may occur (See the Sergents, 1918,[22] Ben Harel, 1923,[23] L. G. Taliaferro, 1925,[21] Boyd, 1924[24] and Hartman, 1927.[25]) Just as in *T. lewis,* there are no tissue localizations so that from the number curve alone we are justified in concluding that some parasiticidal mechanism eliminates most of the parasites at the time of the crisis.

When the rate of reproduction of the organisms is studied, however, we find an entirely different picture from that in *T. lewisi.* L. G. Taliaferro (1925)[21] found that the rate of reproduction of the parasites remained constant during the acute, chronic and relapse periods. In other words, the parasites reproduced every 24 hours whenever they could be found

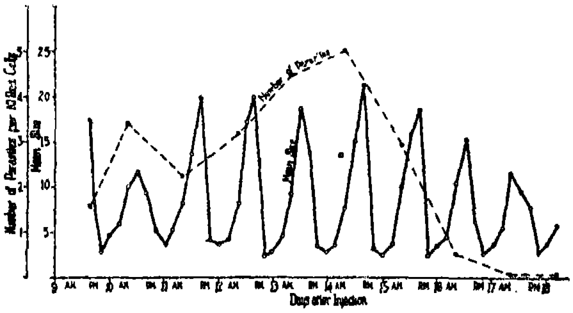

FIG. 4. Graph showing the plasmodicidal factor of resistance developed in a bird against an infection with *P. cathemerium* as represented by tho crisis in the number curve. There is no reproduction-inhibiting effect as shown by the regularity of the mean-size curve, *i.e.,* every 24 hours the parasites sporulated. (From L. G. Taliaferro.)

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[21] Lucy G. Taliaferro, *Amer. Jour. Hyg.,* 5: 742–789, 1925.

[22] Ed. Sergent and Et. Sergent, *Ann. de l'Inst. Pasteur,* 32: 382–388, 1918.

[23] S. Ben Harel, *Amer. Jour. Hyg.,* 3: 652–685, 1923.

[24] G. H. Boyd, *Amer. Jour. Hyg.,* 5: 818–838, 1925.

[25] E. Hartman, *Amer. Jour. Hyg.,* 7: 407–432, 1927.

in the blood for study. Fig. 4 shows the regularity of the mean curve during the major portion of the acute period, the crisis and the beginning of the latent period of an infection. From this it follows that there is no reproduction-inhibiting effect of resistance such as exists in infections with *T. lewisi*.

The parasiticidal effect may now be considered in detail. As was previously indicated, the average number of merozoites formed from one parasite was found to be 15.5 and on *a priori* grounds the daily rate of increase of the parasites during the acute period should be the same. Number counts, however, revealed that the increase was only by 5. In other words, each schizont produced a brood of approximately 15 parasites, but ten of them died before completing their reproductive cycle. This rate of death occurred immediately after the bird was infected and was constant throughout the acute period. It does not, therefore, represent an acquired resistance, but probably is a measure of the suitability of birds for the malaria parasite and represents in a sense a natural immunity. Whether or not it is the result of active processes in the bird, such as specific phagocytosis, or is a natural death rate of the parasites, as suggested by Hartman (1927),[25] has not been definitely proven.

At the time of the crisis instead of 10 parasites out of each brood of 15.5 being killed, the rate of death of the parasites was far in excess of the net rate of reproduction. This represents an acquired resistance resulting from infection which is effective to a greater or less extent in holding the parasites down throughout the remainder of the infection.

That it is preeminently efficient has been demonstrated and directly measured by injecting parasites into a latent bird and comparing their fate with similar parasites injected into a normal bird. One experiment by the speaker and L. G. Taliaferro (1929 a)[26] will illustrate the results obtained. An experimental bird, that is, an immune bird, on the forty-third day of its primary infection when there were no longer parasites in its blood, and a normal bird were given similar intravenous doses of parasites at 1:00 P. M. so that a few minutes later there were 8 parasites per 10,000 red blood cells in their blood. The sequence of events in the two birds was strikingly different. Whereas in the experimental bird the parasites had disappeared by 10:00 A. M. the day after the intravenous injection and never reappeared (the bird died on the eighth day of the experiment), in the control bird they showed a typical course of infection. The results were even more dissimilar when larger doses of parasites were given, for the immune birds disposed of their parasites so that they could no longer be found 2 to 3 days after injection, whereas the normal birds died between the fifth to eighth day from the ensuing overwhelming infection with approximately every other cell parasitized.

Other conclusions from the same paper may be briefly summarized as follows: There is a high degree of immunity to superinfection which begins as soon as the latent period sets in and lasts for extremely long periods. Thus, birds with latent infections that had been inoculated from 16 to as long as 656 days previously, when superinfected, disposed of the parasites quickly, whereas normal birds could not cope with such enormous numbers and quite frequently died. The removal of the parasites in the latent birds depends to a certain degree on the number injected. In other words, when approximately 1 to 100 parasites per 10,000 red blood cells were introduced, they were removed from the peripheral blood within 24 hours, whereas when from 100 to 400 per 10,000 red cells were introduced, they were removed in from 48 to 76 hours. The parasite-red-cell complex is removed throughout the asexual cycle and not simply the merozoites free in the serum, as is evidenced by the fact that when hourly blood smears were made following the intravenous injections the decrease in numbers was gradual and not restricted to the time of sporulation. The ability to remove the parasites is very labile and very delicately attuned to the physiological condition of the bird and may be upset upon the slightest provocation. Thus, of six birds with latent infections, when injected intravenously 33 days after the initial inoculation with the same number of parasites, one had removed them from the blood by the following day, two got rid of them in two days, whereas the other three took three days to dispose of them.

We (W. H. and L. G. Taliaferro, 1929b)[27] then endeavored to find an antibody basis for this parasiticidal activity and naturally looked for some type of antibody similar to the ones easily demonstrated in the trypanosome infections. In this we completely failed. Thus, in six birds which were given varying doses of serum up to 1.05 cc, which is more than the amount obtainable from one bird, the infection showed up within from 1 to 6 days, whereas similar infections in normal birds showed up in from 1 to 9 days. This and other experiments led to the conclusion that immune serum, *i.e.*, serum recovered from birds during a latent malarial infection, was without curative, protective or opsonizing effect on the parasites. Nevertheless, at the close of this talk, I shall present evidence which still makes me feel that either some type of antibody must be present or the macrophages must be specifically changed.

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[26] W. H. Taliaferro and Lucy G. Taliaferro, *Jour. Prev. Med.*, 3: 197–208, 1929a.

[27] W. H. Taliaferro and Lucy G. Taliaferro, *Jour. Prev. Med.*, 3: 209–223, 1929b.

The absence of an antibody basis for the high grade immunity to superinfection and the subsequent natural recovery from avian malaria made it all the more interesting to study the cellular basis for the effects we have described. This phase of the work has been done in collaboration with Professor P. R. Cannon, of the department of pathology of the University of Chicago (1931).[28] A study was made first of normal birds and of the cellular changes occurring in infected birds throughout the course of infection and these changes in turn were correlated with the various periods of the infection. Second, a comparison was made between the cellular reactions immediately following the introduction of a large number of parasites into a normal bird and into a latent, *i.e.*, immune bird. This second study gave a picture of the cellular basis for the parasiticidal mechanism that we have been considering.

The cellular reactions throughout the course of normal infections presented a picture of increasing activation of the mesenchyme which reached its height at the time of the crisis and continued to a lesser degree throughout the entire latent period of the infection. This activation of the mesenchyme was not only indicated by the increased mitoses and increased numbers of the undifferentiated lymphoid cells, but by the heightened phagocytic activity and increased numbers of the differentiated macrophages, particularly of the spleen and liver. Furthermore, the spleen was greatly enlarged.

An occasional phagocytosed parasite was found in the spleen and liver as soon as four hours, and thereafter, phagocytosis was constant and continued throughout the acute period—thus, directly verifying the decrease of the asexual forms as indicated by number counts. Evidences of activation first appeared in about 18 hours, were quite pronounced by 24 hours and then were increasingly apparent until they reached a climax between the eighth and tenth days concomitantly with the crises of the infection. At the time of the crisis, when so many parasites were being swept from the general circulation, the Kupffer cells in the liver were swollen and contained large numbers of malarial organisms and there was a striking increase in mitosis and in the number of mononuclear cells. The liver cords were notably disoriented. Similarly in the spleen there was a larger proportion of pulp cells (macrophages) containing malarial organisms coupled with a diffuse hyperplasia of lymphoid cells and a great increase of basophilic lymphoid cells. After this high point of activation, there was a gradual decline in phagocytosis and activation. This probably follows from the fact that once the body has gotten the infection in hand, there are comparatively few parasites present for removal. Nevertheless, that the altered reactivity is maintained is demonstrated conclusively when a large number of parasites is injected. Under such conditions phagocytosis is much more rapid and effective than in birds infected initially. In fact, it is well initiated within fifteen minutes after superinfection and within from 24 to 48 hours has so successfully operated that parasites can no longer be found in the peripheral blood. It is interesting to note that throughout our study the actual phagocytosis of the parasitized red cells is limited to the macrophages, that is, to the cells known under such various names as the hemophages of Kyes, the Kupffer cells in the liver, the pulp cells in the spleen, etc.

With this background it is possible to state very briefly our results on the cellular basis for immunity to superinfection. It will be recalled that when parasitized red cells were introduced into normal birds no appreciable phagocytosis of the organisms occurred before four hours and no distinct activation of the mesenchyme before 18 hours. In marked contrast to this when similar parasitized red cells were introduced into immune birds, phagocytosis was well initiated within 15 minutes and practically all of the parasites were removed within from 24 to 48 hours. The parasiticidal mechanism, then, involved in the destruction of the parasites at the time of the crisis, during the post-critical period, during latency and during immunity to superinfection, is primarily a cellular response of the host involving an activation of the mesenchyme. This activation, furthermore, is effective through two factors: (*a*) an actual increase in the number of phagocytic cells and (*b*) a greatly increased rate of phagocytosis by the individual macrophages.

The picture might be considered more or less complete were the activation of the mesenchyme non-specific, since then, of course, the absence of opsonizing antibodies would be accounted for, but Gingrich (1930)[29] has demonstrated that between *P. cathemerium* and *P. elongatum* the immunity is specific. Thus, during a latent infection with *P. cathemerium* there was an immunity to a superinfection of *P. cathemerium*, but not to an initial infection of *P. elongatum*, and *vice versa*. This demonstrates that the bird during latency acquires some mechanism which causes its phagocytes to ingest specific parasites and suggests either the production of a tropin which we have failed to demonstrate in our serological experiments, or a qualitative change in the macrophages. This whole question of the specificity of cellular responses in acquired immunity has been ably discussed in an earlier Harvey Lecture by Professor Gay (1931).[20]

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[28] P. R. Cannon and W. H. Taliaferro, *Jour. Prev. Med.*, 5: 37–64, 1931.

[29] W. Gingrich. Dissertation. Johns Hopkins School of Hygiene and Public Health, 1930.

The question immediately arises: Does the picture which I have presented for avian malaria hold for malaria in man and other mammals? At the present time Mrs. Taliaferro and I are carrying out a similar study on *P. brasilianum* of Panamanian monkeys which is a quartan parasite almost identical with *P. malariae* of man. Similarly, Professor P. R. Cannon is making a study of the cellular reactions of the monkey to this infection. It is too soon to give you the final results of this work, but the following preliminary conclusions are justified. The entire picture of the ordinary course of the infection is similar to that in the bird with certain time differences. There is no indication of any inhibition of reproduction of the parasites, but the number curves show that plasmodicidal factors are operating. So far we have not been able to correlate the killing of the parasites with any plasmodicidal antibody, but only with the direct phagocytosis of the parasites by the differentiated macrophages. The cellular responses during the initial infection are similar to those in birds. There are increasing evidences of activation of the mesenchyme during the acute rise of the infection which reaches its height at the time of the crisis and slowly subsides as the developed infection progresses and latency is initiated. There is also a high degree of immunity to superinfection during latency, which can be demonstrated by the injection of washed parasitized cells into monkeys with a latent infection, but so far no work has been done on the cellular basis for this immunity.

In comparing the immune reactions in infections with *T. lewisi* and *P. cathemerium* it is quite remarkable that the immediate mechanisms of immunity and effects on the parasites are so different, and yet, that in both cases the immunity can be eventually ascribed to the macrophage system. Thus, in one case the immunity is associated with an antibody which inhibits reproduction and with one or more trypanocidal antibodies, whereas in the other case there is no inhibition of reproduction and the parasiticidal mechanism consists of direct phagocytosis without the intervention of any humoral tropin that has been demonstrated up to the present.

These investigations on the cellular phases of immunity to protozoan infections are but one phase of the growing mass of evidence indicating the rôle of the macrophages in general and local immunity, in antibody production, in chemotherapy and in normal metabolism (see Linton, 1929;[30] Jungeblut, 1930,[31] and Gay 1931).[20] There are many obvious similarities between the work which I have presented and these subjects. I would like particularly to mention the following: The cellular responses to malaria show a striking similarity to the morphological changes described by Epstein (1929)[32] in the spleen and liver of the rabbit following the injection of such non-infectious antigens as sheep cells and horse serum. They parallel very closely the conditions found in other infections, such as *Bartonella,* to cite a single example in which the cellular responses have been very accurately studied (see particularly Cannon and McClelland, 1929;[19] Eliot and Ford, 1929,[33] and Marmorston-Gottesman and Perla, 1930[16]). And finally, although the cellular responses to malaria give rise to a general immunity, the same responses are probably elicited in so-called local immunity (see Gay, 1931[20]).

CONCLUSION

In concluding I wish to draw particular attention to the peculiar value of the blood protozoa for the study of what I believe to be some of the fundamental problems of immunity. All of these problems are related to the two great questions of how the host responds to infection and how the host's responses affect the invading organisms. The advantages of the protozoa in studying these questions may be briefly summarized as follows:

(1) *The analysis of the effects of resistance on the invading organism.* The fact that some protozoa live in and are evenly distributed through the blood stream allows the study of the course of infection from day to day. The further fact that the protozoa are comparatively large permits the study of cell-division and their general behavior throughout the course of infection. Specifically, I have shown that taken together such studies differentiate sharply between those factors in the host's resistance which kill the parasite, *i.e.,* parasiticidal factors, and those factors which inhibit cell-division, *i.e.,* reproduction-inhibiting factors. Although parasiticidal factors, such as trypanolysins and direct phagocytosis of organisms are well known, we have been able to demonstrate in one infection a peculiar type of antibody-response which does not kill the organisms, but which inhibits cell-division. These methods of analysis probably can not be applied to the smaller bacterial invaders although we have had some success in applying them to spirochaetes.

(2) *The action of antibodies on the protozoa.* The

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[30] R. W. Linton, *Arch. Path.,* 6: 488–501, 1929.

[31] C. W. Jungeblut, *Ergeb. Hyg. Bakt. Immun. u. Exp. Therap.,* 11: 1–67, 1930.

[32] E. Epstein, *Virchows Arch.,* 273: 89–115, 1929.

[33] C. P. Eliot and W. W. Ford, *Amer. Jour. Hyg.,* 10: 635–642, 1929.

same characteristics of the blood protozoa listed above permit the direct study of the action of antibodies on the invading protozoa *in vivo*. Thus, when an immune serum is tried curatively, it can be ascertained by direct blood examination whether the organisms are killed or not. Similarly, the action of the reproduction-inhibiting antibody can be observed, that is, the presence or absence of cell-division can be directly ascertained. Here again the only methods available for similar studies with the smaller bacterial invaders are at best indirect.

(3) *The cellular basis of immunity.* The blood protozoa have proved admirable material for the correlation of cellular responses with immunity, antibody formation, etc. Thus, in the study of the production of the reproduction-inhibiting antibody in *T. lewisi* infections, it has been possible to use the trypanosomes as a delicate measure of the activity of the macrophage system. Similarly, in the acquired immunity of birds to malaria it has been possible to correlate the course of infection and immunity with the cellular responses. In fact, the malarial organisms have proven to be particularly advantageous for this type of study not only because they are large and can be easily found in the tissues, but also because even after digestion they leave a landmark for a considerable length of time in the form of the less readily digested pigment.

Lest I be misunderstood as suggesting the use of the blood protozoa for the study of all of the fundamental problems of immunology, I should also like to point out some of their shortcomings. Not even all the blood protozoa can be used for the studies I have presented this evening. Some of them, such as *T. cruzi*, the causative agent of Chagas's disease, form reproductive centers and localizations in the tissues which make the study of the normal course of infection by blood examinations impossible. Others, such as *P. falciparum*, the causative agent of estivo-autumnal malaria in man, although confined to the blood, show localizations in the capillaries of certain organs which thereby prevent the study of the course of normal infections by routine peripheral blood samples. The fact that the protozoa used in these studies are distributed throughout the blood stream prevents their use for studies in local immunity. Finally, inadequate cultural methods eliminate both the blood protozoa in particular and all protozoa in general as good material for the study of the serology and chemistry of immunological processes.

OBITUARY

ASHE, PIONEER FORESTER AND BOTANIST

THE death of William Willard Ashe on March 18, 1932, removes another distinguished name from the fast dwindling ranks of foresters who received their training in an era when the country was without established schools for education in the forestry profession. Ashe was born in Raleigh, N. C., on June 4, 1872, the oldest of nine children born to the Honorable Samuel A'Court Ashe and Hannah Emerson (Willard) Ashe. Ashe was noted as a boy for his love of nature, versatility, originality and for his mechanical and artistic ability. He was educated at the Raleigh Male Academy, the University of North Carolina (B. Litt., 1891), and Cornell University (M. S., 1892), specializing in geology and botany. He studied medicine for a while under Dr. W. I. Royster, of Raleigh. He was a member of the Sigma Alpha Epsilon fraternity. From 1892 to 1905 he served as forester of the North Carolina Geological Survey under Dr. J. A. Holmes. From 1905 until his death Ashe was an officer of the U. S. Forest Service, rising steadily in rank from forest expert and forest assistant to assistant district forester and senior forest inspector in "Region 7" (eastern United States). In 1906 he married a widow and distant cousin, Margaret Henry Wilcox. He had no children. Ashe was secretary of the National Forest Reservation Commission and editor of its reports from 1918 to 1924. He was elected vice-president of the Society of American Foresters in 1919. He became a member of the Forest Service tree name committee in 1928 and was chairman from 1930 to his death.

Ashe was a true pioneer. He was one of the real fathers of the forest acquisition policy of the federal government and was among the first to recognize the need for forest research in this country. He planted one of the first commercial stands of longleaf pine in North Carolina and discovered the secret of its successful transplantation. He is credited with introducing the modern cupping system in the American naval stores industry.

A bibliography of Ashe's scientific papers compiled by the writer covers 166 titles. He wrote extensively on systematic botany, logging costs, profitable forest management, land acquisition for conservation purposes, forest influences and forest types. One of the last papers he issued was a monograph of the genus Polycodium.

Ashe was an indefatigable observer, collector and annotator of plants. He published 510 new names in 35 genera. His taxonomic interests were (aside from his early papers in Asarum and Panicum) largely in connection with woody plants of the Southeast; 86 per cent of his botanical novelties are in the five families Rosaceae (including Malaceae), Ericaceae (including Vacciniaceae), Juglandaceae, Fagaceae and Poaceae.

Ashe was a quiet and retiring man, a hard worker, utilizing his personal time largely in study and writing; he was keenly observant, markedly original and independent, with a fine sense of humor, and with high standards of thought and conduct.

WILLIAM A. DAYTON

RECENT DEATHS

DR. WILLIAM W. KEEN, emeritus professor of surgery at Jefferson Medical College, Philadelphia, died on June 7 at the age of ninety-five years.

DR. NATHAN AUGUSTUS COBB, of the Bureau of Plant Industry of the Department of Agriculture, died on June 4 at the age of seventy-three years.

DR. VIRGIL COBLENTZ, of Philadelphia, formerly professor of chemistry in the New York College of Pharmacy and chief chemist of E. R. Squibb and Sons, died suddenly on June 10. He was seventy-six years old.

EDWIN JULIUS BARTLETT, professor emeritus of chemistry at Dartmouth College, died on June 10 at the age of eighty-one years.

HERBERT PARLIN JOHNSON, formerly assistant professor of zoology in the University of California and associate professor of bacteriology in the School of Medicine at St. Louis University, died suddenly on April 29 at the age of sixty-eight years.

THE death is announced on May 29 of Dr. Cuthbert Christy, London naturalist, explorer and expert in tropical diseases. He was sixty-eight years old.

MISS NORA E. DALBEY, associate professor of botany, Kansas State College of Agriculture and Applied Sciences, who was carrying on special work in cytology while on leave of absence, died at Merritt Hospital, Oakland, California, on May 29. Miss Dalbey received her bachelor's and master's degrees from the University of Kansas. She has been at Kansas State College since 1918.

A CORRESPONDENT writes: "Anthony Spuler, associate entomologist of the Washington Agricultural Experiment Station, State College of Washington, Pullman, and Mrs. Spuler were drowned at Lake Wenatchee, Washington, on Memorial Day when their small motor boat capsized in a storm. Mr. Spuler received his bachelor's degree in zoology in 1917 and his master's degree in 1919 from the State College of Washington, and has been a member of the teaching and experiment station staff of that institution since his graduation. He was best known for his work in developing the use of moth traps as an indicator of the time to spray for codling moth control and for his research on oil sprays and other insecticides. Many of the results obtained in his investigations are the bases of established orchard practices in the Pacific Northwest."

Nature records the deaths of R. H. Adie, formerly secretary of the School of Agriculture, University of Cambridge, and the Hon. Mrs. Huia Onslow (Muriel Wheldale Onslow), university lecturer in plant biochemistry in the University of Cambridge.

SCIENTIFIC EVENTS

GIFTS TO THE BRITISH NATURAL HISTORY MUSEUM

AMONG the important acquisitions made by the Trustees of the British Museum (Natural History) and reported in the London *Times* are two considerable gifts from Mr. A. S. Vernay.

Some 60 mammals and 590 birds obtained by the Vernay-Lang expedition to the Kalahari Desert in 1930 have been presented by him, together with 264 flowering plants and ferns from the same region. The mammals include specimens of 11 forms described in South Africa as new to science, and the plant collections, from an area poor in flora and imperfectly known, make a welcome addition to the small representation hitherto possessed by the museum. The second gift from Mr. Vernay consists of 184 mammals, 29 reptiles, 34 fishes and 500 butterflies obtained by Captain Beresford Holloway, who accompanied the donor on his recent expedition to the Malay peninsula.

Other zoological gifts include 70 big-game trophies from India and Africa presented by Sir Richard Dane, and a collection made by Dr. E. B. Worthington during the Cambridge University expedition to the East African Lakes. In this are included 102 reptiles and amphibians, 900 fishes (including about 30 new species), and many molluscs and other invertebrates.

A gift to the Department of Botany is the British herbarium of the late Dr. John Thomas Irwin Boswell (1822–88), presented by Mr. F. J. Hanbury. This herbarium comprises about 20,000 sheets of well-mounted plants, contained in 14 mahogany cabinets. Boswell was the editor of the monumental third edition of the "English Botany," and was long connected with the Botanical Exchange Club as distributor. The accuracy and detail of his descriptions was based upon the material in this collection, which will be kept intact by the wish of the donor, who purchased it on Boswell's death. A collection of 372 Tanganyika plants has been bought for the department of botany, and the department of geology has bought a specimen of the teeth of the extinct shark *Edestus* from the Devonian rocks of Rhenish Prussia.

Samples of volcanic dust which fell after the recent eruptions in the Andes have been presented to the department of minerals by the proprietors of *The Times* and by Messrs. H. W. Nelson, Limited. Professor G. Vibert Douglas has collected and presented a large series of rocks illustrating the geology and mineralization of several mines in the "copper belt" of Northern Rhodesia and Katanga, and purchase has been made of a series of exceptionally fine crystals from the Tsumeb copper mines in Southwest Africa. Copper, zinc and lead minerals are represented—among them cerussite, anglesite, chessylite, smithsonite and mimetite.

THE ENGINEERING SOCIETIES LIBRARY

THE Engineering Societies Library, New York, reports that, for the first time since the depression began, inquiries are falling off. Geographically, the decrease is uniform, indicating a lessening of industrial and engineering effort in all nations.

Library readers, however, continue to increase. They were ten per cent. more numerous in 1931 than in 1930, and they are still multiplying, according to Director Harrison W. Craver. The present economic situation, while slowing up the quest of industry for technical knowledge bearing upon problems of development, has stimulated the individual engineer to greater intellectual effort.

Jobless engineers and scientific men, according to Mr. Craver, are likely, in the long run, to profit by their enforced leisure, for, during the era of prosperity which came to an end in 1929, they were so immersed in the practical aspects of the tasks that they had little opportunity to keep abreast of engineering advances in other than their own specialized fields. Hence, it is believed, one result of the economic recession will be a broadening of the outlook of the professional engineer in all countries.

"Not until recently," Mr. Craver said, "did the depression affect us at all. Last year nearly 50,000 requests to supply technical information, a record number, were received. This represents a gain of several thousand over the previous year. But now, the slump in industrial operations is being reflected in a diminished demand for investigating service at the library.

Requests for facts, nevertheless, are coming from practically every country and from every state in the Union. They cover almost the entire range of engineering, according to Julian A. Sohon, chief bibliographer.

Soviet Russia, Mr. Sohon said, frequently asks for technical advice through the office of the Amtorg in New York. American engineers working in Russia also write for assistance from time to time.

The New Zealand Government is another conspicuous source of queries, particularly with respect to public works. Many Swedish engineers also turn to the library, which, despite the low ebb of engineering activity, is developing its facilities in preparation for a great industrial era which, engineers believe, lies ahead.

The library is the largest strictly engineering library in America, and probably in the world. It now contains 128,000 volumes, 5,000 pamphlets, 6,321 maps and 3,872 searches. Alten S. Miller, of New York, is chairman of the Library Board for 1932.

FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

THE second annual field conference of Pennsylvania geologists was held in the Lehigh Valley on May 28, 29 and 30, the geology departments of Lehigh University and Lafayette College acting as hosts. Especial mention should be made of the efficient manner in which the trips were planned and carried out, thanks to the able work of the committee in charge, consisting of D. Fraser, A. H. Fretz, B. L. Miller and L. Whitcomb, of Lehigh, and C. K. Cabeen, H. A. Itter, H. Koerner and F. Ward, of Lafayette. About 75 members and guests from outside Pennsylvania registered at Markle Hall, Lafayette College.

On the afternoon of Saturday, May 28, two field trips were offered simultaneously, the visitors choosing between them. Trip No. 1, under Professor Itter, of Lafayette, covered the three members of the Triassic System exposed along the Delaware below Easton, the well-known "Ringing Rocks" and certain exposures of the Cambrian and Pre-Cambrian. Trip No. 2 visited the cement and slate belts of the Lehigh Valley, including quarries and mills, and proved of unusual interest to the non-metallic economic geologists. It was in charge of Dr. B. L. Miller, of Lehigh University. The Saturday activities finished with an informal dinner at Easton. President W. R. Lewis extended a welcome from Lafayette College, and various members spoke very briefly upon the local geology. During a short business session the by-laws drawn up by committee were adopted. These included the appointment of a permanent secretary-treasurer, who must be a member of the Pennsylvania State Geological Survey. Dr. Bradford Willard was selected for this position.

The Sunday, May 29, trip was attended by the entire assembly. The party left Easton by automobile and proceeded up the Delaware Valley to the Water Gap, thence to Stroudsburg, crossed to the Lehigh River, and thence traveled south to Bethlehem. The trip included visits to exposures of most of the formations from the Pre-Cambrian through the Upper Devonian beside Pleistocene deposits and various economic features such as cement, slate and metallic paint ore. The excursion was successively led by Professor Freeman Ward, of Lafayette, Dr. Bradford Willard, of the State Survey, Professor Frank Swartz, of Pennsylvania State College, and Dr. B. L. Miller, of Lehigh University. At Bethlehem dinner was served at the Hotel Bethlehem and was followed by a welcome from President C. R. Richards, of Lehigh, after which Professor H. Ries, of Cornell, spoke briefly.

On the thirtieth the conference ended in the members and guests selecting one of three trips. The first under Dr. B. L. Miller, of Lehigh, was largely devoted to metallic economic geology in that visits were made to abandoned iron pits and the old zinc mines of the Saucon Valley south of Bethlehem. The second trip, conducted by Professor Freeman Ward, of Lafayette, was devoted to a study of the glacial deposits, chiefly with a view of observing the differences between and the interrelations of the Illinoian and Wisconsin drifts. Those who selected the third trip were led by Dr. Lawrence Whitcomb, of Lehigh, to Spitzenberg, a conical hill near Lenhartsville, some thirty miles west of Bethlehem. The purpose of this visit was to inspect the peculiar limestone conglomerate which rests upon the Ordovician shale near the crest of the hill.

It is planned to hold the annual meeting of the conference for 1933 at Harrisburg as guests of the Pennsylvania Topographic and Geologic Survey. This is scheduled tentatively for the last week-end in May and will cover the Silurian-Devonian-Mississippian sections of the Susquehanna and Juniata Valleys, the Triassic and pre-Silurian Paleozoics between Harrisburg and York, including a visit to the Cornwall Iron Mines, and the river terraces, the peneplanes, and other physiographic features of the neighborhood.

Bradford Willard,
Secretary-Treasurer

THE NEANDERTAL RACE IN PALESTINE

The discovery during the first two weeks in May of seven skeletons of the Neandertal race is destined to throw a flood of light on that particular species of fossil man. The specimens hitherto found in Europe have been so few and fragmentary that there was little evidence to suggest that the race or species might include a number of varieties. The first intimation of marked variation came with the discovery of the skull at Broken Hill, Rhodesia, some ten years ago. In 1925 Turville-Petre found a portion of the cranial cap of a Neandertal skull in the Cave of the Robbers near the Sea of Galilee. But the fragment being small (frontal and one cheek bone) gave no indication of variation from the European type.

The seven individuals just found in the Cave of the Kids near Haifa by Theodore D. McCown, field representative of the American School of Prehistoric Research and in charge of the joint excavations of the American and British Schools, will, on account of their relative completeness, throw new light not only on the species as a whole, but also point to a Palestinian variety of the Neandertal species. A tracing just received of one of the best preserved adult skulls shows that the latter agrees with the European type in the marks of a powerful musculature, massive brow ridges, taurodont dentition and prognathism. But the prognathism is confined largely to the upper jaw and the dentition. The chin can scarcely be called receding and the frontal and parietal portions of the skull are more highly developed than in the known European examples.

It is especially fortunate that these seven skeletons, as well as that of a Neandertal child found (also by McCown) in the same cave one year ago, were all *in situ* and associated with industrial remains of the Mousterian Epoch. McCown states that one of the adult skeletons was found clasping to his breast a huge jaw of the wild boar.

The skeletons were lying near the bedrock and in a stony matrix. McCown is bending every effort to remove them safely from the deposit and ship them to London in time for exhibition at the International Congress of Prehistoric and Protohistoric Sciences which meets from August 1 to 6.

George Grant MacCurdy

SCIENTIFIC NOTES AND NEWS

The preliminary program of the meeting of the American Association for the Advancement of Science, to be held at Syracuse, New York, from June 20 to 25, was published in the issue of Science for May 27. Some seventeen associated scientific societies will meet with the association. The first general session, followed by a reception, will be held on the evening of Monday, June 20, under the presidency of Dr. John J. Abel, professor of pharmacology, emeritus, at the Johns Hopkins University. Dr. Edward L. Thorndike, professor of educational psychology at Teachers College, Columbia University, will make the address.

The first meeting of the council will be held at 9 o'clock on Tuesday morning. As has been noted in the preliminary announcement, there will be a full program of symposia and general addresses with special opportunities for excursions and field trips.

NEW YORK UNIVERSITY conferred at its graduation exercises the doctorate of science on Dr. William H. Welch, professor emeritus of the history of medicine at the Johns Hopkins University, who was from 1879 to 1884 professor of pathological anatomy and general pathology in the New York University and Bellevue Hospital Medical College.

THE University of Würzburg, at the three hundred and fiftieth anniversary of its foundation on May 2, conferred the degree of doctor of medicine *honoris causa* on Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington.

THE honorary degree of doctor of science was conferred on June 16 by George Washington University on Dr. Frederick Parker Gay, head of the department of bacteriology in the College of Physicians and Surgeons of Columbia University; on Dr. George Canby Robinson, director of the New York Hospital and Cornell Medical Association, and on Dr. Alan Mason Chesney, dean of the Johns Hopkins University School of Medicine.

THE degree of doctor of science will be conferred on Dr. Walter C. Mendenhall, director of the U. S. Geological Survey, by the University of Wisconsin, on June 20.

AT the seventy-seventh annual commencement of the Polytechnic Institute of Brooklyn the honorary doctorate in science was conferred upon Dr. Moses Gomberg, chairman of the department of chemistry at the University of Michigan, and on Professor Irving Wetherbee Fay, of the institute, who becomes professor emeritus of chemistry after thirty-five years of service at the college.

THE staffs of the College of Engineering and the Engineering Experiment Station of the University of Illinois gave a dinner on May 25 in celebration of a decade of progress of the College of Engineering under the guidance of Dr. Milo S. Ketchum as dean of the College of Engineering and director of the Engineering Experiment Station. Short addresses were made by Dr. A. N. Talbot, Assistant Dean H. H. Jordan and Professor W. C. Huntington. Professor A. C. Willard presented an illuminated parchment to Dean Ketchum on behalf of the members of the staffs of the College of Engineering and the Engineering Experiment Station. Dean Ketchum made a brief response. The parchment contained the following note of appreciation: "The staffs of the College of Engineering and the Engineering Experiment Station of the University of Illinois upon the completion of a decade of service by Milo Smith Ketchum as dean and director unite in expressing to him their appreciation of his able guidance and leadership in the affairs of the college and station during the ten years and in wishing him every success in the years that are to come."

THE Society for Experimental Biology and Medicine at its recent annual meeting elected the following officers: *President,* A. R. Dochez; *Vice-president,* E. L. Opie; *Secretary-Treasurer,* A. J. Goldforb; *Council,* W. B. Cannon, A. E. Cohn, L. J. Cole, W. O. Fenn, M. S. Fleisher, W. H. Harris, W. J. MacNeal, W. Ophüls, W. J. V. Osterhout, W. W. Palmer, S. W. Ranson, F. R. Sabin, F. H. Scott, R. W. Scott, C. M. Van Allen and E. Witschi.

DR. GEORGE W. BACHMAN has been appointed director of the School of Tropical Medicine, San Juan, Puerto Rico. The school is under the auspices of Columbia University. Dr. Bachman, who has been acting director of the school for the last year, succeeds Dr. Earl B. McKinley, who resigned to become dean of the George Washington University School of Medicine. Dr. Bachman was also promoted from associate professor to be full professor of parasitology.

DR. JAMES W. GLOVER, who has been on leave of absence from the University of Michigan, and who has been president of the Teachers Insurance and Annuity Association of America, has resigned from his position in the association and will resume his professorship of mathematics at the University of Michigan beginning with the coming academic year.

PROFESSOR R. S. SETON, head of the department of agriculture of the University of Leeds, retires at the end of the academic year.

THE Committee on Scientific Research of the American Medical Association has given to Dr. Daniel A. McGinty, of the department of physiology, Emory University Medical School, a grant for the continuation of studies on the coronary circulation. Two previous grants for similar work have been given to Dr. McGinty by the committee.

THE Barnard Free Skin and Cancer Hospital, St. Louis, has been awarded a grant by the American Medical Association, for a study of the problem "The Potential Infiltrative Nature of the Virus of Warts" to be carried out under the direction of Dr. M. G. Seelig.

CURATOR FRANK C. BAKER, of the Museum of Natural History, University of Illinois, will continue his studies of the pulmonate fauna of the state of Illinois, begun last summer, for the State Natural History Survey of Illinois. He will be assisted by Mr. Dale Foster, graduate student in zoology of the university. Particular attention will be given to the valley of the Mississippi River, which will be surveyed from Jo Davies County to southern Illinois.

Mr. Seido Endo, instructor in geology at Tohoku Imperial University, Sendai, Japan, is spending the next two years in paleobotanical studies with Professor E. W. Berry at the Johns Hopkins University.

Dr. W. McKim Marriott, dean and professor of pediatrics, Washington University School of Medicine, St. Louis, will be the lecturer at the University of California Medical School for the year 1932–1933. Dr. Marriott, who will be at the medical school early in the fall of this year, will conduct lectures and clinics.

Dr. Rudolph Matas, emeritus professor of surgery, Tulane University of Louisiana School of Medicine, New Orleans, delivered the sixth annual Donald C. Balfour Lecture at the University of Toronto Faculty of Medicine, on "The Story of Postoperative Pulmonary Embolism before and after Lister." The date was the one hundred and fifth anniversary of the birth of Lord Lister.

The Herbert Spencer lecturer for this year was Dr. Ronald Aylmer Fisher. The lecture was given on June 8 under the title of "The Social Selection of Human Fertility."

Professor C. U. Ariëns Kappers delivered the David Ferrier Lecture at the Royal Society on June 2, taking as his subject "Some Correlations between the Brain and the Skull."

Professor Werner Heisenberg, of Leipzig, Professor George Gamow, of Leningrad, and Professors Samuel A. Goudsmit and David M. Dennison, of the University of Michigan, will participate in the fifth Symposium on Theoretical Physics to be given at the University of Michigan during the summer session, June 27 to August 19. The lectures by Professors Gamow, Goudsmit and Dennison will begin on the opening day of the session, June 27. Due to the fact that Professor Heisenberg will be detained in Leipzig on account of official duties at the university his lectures will not begin until Monday, July 11.

The thirty-fifth annual meeting of the American Society for Testing Materials will be held in Atlantic City from June 20 to 24. On Tuesday, June 21, symposia will be held on "Textile Materials" and on "Steel Castings." On Wednesday sessions will be devoted to steel, magnetics and insulating materials. The seventh Edgar Marburg Lecture, "Fundamentals in the Problem of Resistance to Deterioration," will be given on Wednesday afternoon by Professor Hugh S. Taylor, of Princeton University. Sessions will be held on Thursday for discussion of the effects of temperature on metals, timber, coal, paving and waterproofing materials and corrosion and fatigue of metals. On Friday programs will be held devoted to cement, lime, gypsum, ceramics, non-ferrous metals, concrete and building stones.

Sigma Pi Sigma, the honorary physics fraternity, installed its twenty-fourth chapter at Miami University, Oxford, Ohio, on June 4. The chapter is designated the Omega chapter. The charter group was composed of about twenty undergraduates, graduate students and faculty members, including Dr. R. L. Edwards, head of the department of physics. Dr. Marsh W. White, of the department of physics at the Pennsylvania State College and executive secretary of the fraternity, was the installing officer. At an open meeting of the chapter following the installation dinner Dr. White gave an address on "Nuclear Physics."

The section of geology of the Ohio Academy of Science held its annual spring field excursion on May 28 and 29, in southern Ohio, devoting attention exclusively to the physiography of the region, especially the drainage changes since preglacial time. The Teays Valley and its tributaries were examined in the area between Portsmouth and Athens, and the relations between the Teays, Deep and present stages were observed. Twenty members, guided by Wilber Stout, state geologist of Ohio, constituted the party.

The one hundredth anniversary of the founding of the British Medical Association will be celebrated at the annual session in London from July 21 to 30. The annual representative meeting will be held on July 21 and the three following week days, while the scientific sections will meet on July 27, 28 and 29. The annual general meeting will be held on July 23, at the British Medical Association House in London.

In opening the new reading rooms at the Institute of Physics, London, on May 24, Lord Rutherford, the president, explained that they were provided to give greater opportunities to the members of the institute and its participating societies. Through the cooperation of the Physical and Optical Societies and the other participating societies, a large number of books and periodicals had been provided. The intention was to gather together a small library of text-books and reference books, and the nucleus of such a library already existed. At the annual general meeting held afterwards, Lord Rutherford said that remarkable progress had been made in the short time since the foundation of the institute. He considered that the institute could justly claim some of the credit for the growing recognition of the value of applied physics, and he urged physicists of every type to regard it as a duty to join the institute. Lord Rutherford was reelected president, Sir Frank Dyson and Sir William Bragg were elected honorary fellows.

WILLIAM H. DONNER, of Villanova, retired steel manufacturer of Pittsburgh, has been elected president of the newly established International Cancer Research Foundation. Mr. Donner, it is understood, has placed at the disposal of the foundation cash and securities on the basis of present values amounting to $2,000,000. This was set aside by Mr. Donner as a trust in 1929 on the death of his son, Joseph W. Donner. Arthur Morton, president of the Pennsylvania Hospital, Philadelphia, is the vice-president of the foundation. The directors are: Thomas S. Gates, president of the University of Pennsylvania; Edward R. Weidlein, of the Mellon Institute for Industrial Research, Pittsburgh, and former United States Senator George Wharton Pepper. In addition to the directors who will administer the foundation, there will be a board of advisory trustees to be selected from among distinguished citizens and scientific men in all parts of the world. They will advise on the selection of the most promising research problems and investigators and decide where the foundation's money can be expended most efficiently. The foundation, it was stated, is interested primarily in securing results by assisting qualified investigators, and money will not be spent on buildings. The foundation stipulates that not more than 35 per cent. of its income shall be allotted to one institution, not more than 50 to 65 per cent. within the United States, and not less than 35 nor more than 50 per cent. outside the United States.

ONE of Audubon's three largest and finest canvases, an oil painting of "Black Cocks" on a grouse moor, has been presented to the Harvard Museum by John Eliot Thayer. Mr. Thayer has recently given the museum his collection of birds' eggs and nests. The painting was done by Audubon in 1827 while he was on a visit to Scotland. It was painted for a Scottish nobleman whose family sold it some years ago to Mr. Thayer. The canvas is about six by nine feet and has the qualities of an eighteenth century landscape.

THE Carnegie Corporation has made an appropriation of $10,000 toward the maintenance of the library of the Medical College of Virginia, which will this summer be housed in a new building. Adjoining the new library of the college the Richmond Academy of Medicine has built its home and library. This will contain the Joseph L. Miller collection of rare first editions, engravings, silhouettes, medical curios, etc. The headquarters of the Medical Society of Virginia will also be in the Academy of Medicine building.

AN offer to pay at the rate of £5,000 a year from July 31, 1932, to July 31, 1933, for the maintenance of an Imperial Forestry Institute in Oxford has been made by the Forestry Commission and the Secretary of State for the Colonies. The only condition is that the university shall make a contribution to the Department of Forestry for the same period at a rate not exceeding £288 a year, in addition to the contribution which was current on March 18, 1924.

THE annual report of the Royal Society for the Protection of Birds, according to the London *Times*, refers to the need for protection for insectivorous migratory birds, in their nesting homes, in lands where they winter, and on passage. The report says that the dramatic rescue of migrating swallows and martins by Austrian and Hungarian animal-protection societies during the sudden snows in the autumn of 1931, and their transportation by aeroplane to warmer lands, threw for a few weeks a floodlight on the subject of migration, and should suggest a sequel more practical than an ephemeral story and photograph. It should spur on investigation into the value of migratory birds and stimulate rational protection. Reported greetings accorded the swallows in Venice contrast oddly, however, with familiar accounts of migrants netted by the *roccoli* and dished up at restaurants, swallows taken at their roosts for millinery, martins' nests knocked down to inculcate tidiness in paper-littered streets. It is stated that the most notable protection afforded migrating birds at present lies in the bird-nests and perches at six lighthouses on migration routes, provided by the society in cooperation with Trinity House. With regard to oil pollution, it is urged that international action can alone remedy an evil for which ships of all nations are responsible.

The Geographical Journal, London, has received through the agency of the High Commissioner for Canada the final figures of population by provinces arrived at through the census taken on 31 May–1 June 1931 by the Dominion Bureau of Statistics. A comparison with the figures for 1921 shows that the total population is 10,374,196, an increase of over 1,500,000 over 1921; and all the provinces, except four, show percentage increases varying from 5 to 30 per cent. The very small population of Yukon Territory has grown by seventy-three persons, but Prince Edward Island, Nova Scotia and the North-West Territories all register a decrease, in the last case of more than 10 per cent. Quebec has the largest numerical increase (513,056), closely followed by Ontario with 498,021; a drop of about 11,000 is recorded by Nova Scotia.

The Alliance nationale pour l'accroissement de la population française, in a study it has recently published on the vital statistics of France for 1931, points out, according to the Paris correspondent of the *Journal* of the American Medical Association, that the birth rate fell off sharply toward the close of the year. A comparison of the birth rate for the corresponding quarters of 1930 and 1931 shows the following differences: first quarter, increase 937; second quarter, decrease 3,537; third quarter, decrease 4,907; fourth quarter, decrease 11,155; for the entire year, decrease 18,662. The number of marriages, furthermore, having diminished by more than 16,000 it is to be feared that the reduction in the number of births may be still greater in 1932. If one notes that, of the 730,000 births in 1931, 55,000 were of children of foreigners, whereas, of the 680,000 deaths, there were only 30,000 deaths of foreigners, it will be seen that the French excess of births over deaths in 1931 was only 25,000. This small excess runs the risk of being transformed next year into a permanent deficit unless something energetic is done to promote a better birth rate. Finally, since the number of emigrants in 1931 exceeded the number of immigrants by more than 25,000, the population of France has in reality diminished, the first time that that has happened since the war.

A 6,000-acre experimental forest, to be used as a "laboratory" for forestry experiments and research, has been established in the Lassen National Forest in California. The tract contains over 3,000 acres of red and white fir timberland on which both mature and small trees are available for future experiments in forestry methods of timber cutting, logging and slash disposal. One fifth of the area is covered with brush fields, the result of repeated fires. Here reforestation will be undertaken by the planting of stock grown at the Forest Service nursery at Susanville, in order to convert those brush fields into commercial forest. Later, one or more portions of the experimental forest will be selected and designated as "natural forests" and will be left unmolested for the purposes of scientific study. The Swayne Mountain Experimental Forest, the first to be established in California, will be under the supervision of the California Experiment Station of the Forest.

DISCUSSION

PHYSIOGRAPHY AND THE DYNAMIC CYCLE

Introduction

In an article in Science and in other recent papers Waldo S. Glock[1] has presented theoretical discussions of several aspects of the physiography of the lands. Contributions to the theory of a relatively new subject are especially welcome, for whether or not they lead to definitive conclusions they incite students to more careful reflection on fundamental principles of their science.

Glock suggests the division of physiography into two phases, an active or dynamic phase which he would call geodynamics, and a static or passive phase, called geomorphology. "Physiography may be approached from a purely dynamic view-point." Accordingly he discusses a "dynamic cycle" supposed to be measurably independent of and in any case different from the "geographic cycle."

The "dynamic cycle of stream systems" is contrasted with the "geographic cycle" of landforms. "A stream is never young, never mature, and never old in a strictly dynamic sense, for the processes, although they vary in intensity, vary little if at all in quality." In the dynamic cycle streams first pass through a phase of extension, "a time of conquest and minute invasion"; later through a phase of integration, "a time of withdrawal and consolidation," in which tributaries are eliminated "until merely a skeletonized framework remains to care for drainage." These two phases are not necessarily distinct but may overlap, at least locally.

Geomorphology is regarded as static or passive, and "is concerned with the details of surface configuration expressed first by the origin of that form and second by the influence of lithology and rock structure. The method of origin has interest only because it explains and rationalizes important lineaments in the composition of the landscape." The geographic cycle "stands out as the quintessence of geomorphological description."

What is Physiography?

In 1869 Huxley delivered a series of twelve lectures on natural phenomena under the auspices of the London Institution. To distinguish his subject from the elementary works on physical geography of his day he borrowed the term "physiography" which had long been applied, in a different sense, to a department of mineralogy. The lectures were published in 1878 under the title "Physiography, an Introduction to the

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[1] Waldo S. Glock, "Dual Nature of Physiography," Science, n. s. 72, pp. 3–5, 1930; "The Development of Drainage Systems and the Dynamic Cycle," *Ohio Jour. Sci.* 31, pp. 309–334, 1931; "The Development of Drainage Systems: A Synoptic View," *The Geogr. Rev.*, 21, pp. 475–482, 1931.

Study of Nature." While no attempt was made to present a complete or balanced treatise, we find chapters on the figure of the earth, its movements, and the sun; on the atmosphere, rain and dew, snow and ice, and evaporation; on the sea and its work, coral land, and the distribution of land and water; and on the land and land waters, earthquakes and volcanoes. Huxley did not present his chapters in the order given above, nor name the groupings of chapters actually employed; but it is clear that for him "physiography" in its newly adopted usage comprised the earth as a globe in the solar system, the atmosphere, the oceans and the lands.

In the latter part of the nineteenth century the term "physiography" began widely to be substituted for physical geography, particularly for the more advanced study of physical geography, including everything commonly comprised by the double term. The literature of this period contains frequent repetitions of the expression "physical geography, or physiography," thus showing how fully the two terms were regarded as identical. As Davis[2] wrote in 1902, "In recent years there has been a tendency to compress the name (physical geography) into the single word 'physiography' "; and the content of the subject he thus sets forth: "The four chief divisions of physiography are the earth as a globe, the atmosphere, the oceans, and the lands."

This conception of the term "physiography" has endured to the present time, and of six general textbooks on physiography before me, all but one treat the four standard subdivisions of the subject as enumerated above by Davis. The one exception treats three out of the four subdivisions. It is true that certain regional physiographies deal only with physiography of the lands or of the lands and the atmosphere (especially climate). It is equally true that in America, where instruction in physiography has commonly been given in departments of geology and where the physiography of the lands has been emphasized as of particular interest to geological students, some geologists have come to think of physiography as relating only to the lands. But these exceptions should not blind us to the fact that "physiography" has enjoyed wide-spread and long-established usage as a convenient term by which to denote the serious scientific study of man's physical environment in its fourfold character. Our dictionaries and encyclopedias recognize this usage as the standard one, and it is exceptional when one records the fact that the term is "limited by some to that branch of the subject dealing with the land."

The four subdivisions of physiography have grown to dimensions justifying special names. The earth as a globe is perhaps more often treated under the not wholly satisfactory terms "astronomical geography" or "mathematical geography," than under more technical but possibly more satisfactory names. Physiography of the atmosphere has become the modern meteorology and climatology. Physiography of the oceans is often called oceanography, or physical oceanography, to distinguish it from biologic aspects of the sea. For physiography of the lands the term geomorphology has gained wide usage here and abroad.

It is with these general considerations in mind that the reader should weigh Glock's suggestions regarding physiographic terminology and methods of physiographic study. Apparently Glock would restrict the term "physiography" to physiography of the lands. Even when he employs the older term "physical geography" he tells us that "physical geography has a dual nature," and divides it into two parts only just as he does physiography, with both its "active" and "passive" phases relating to land surfaces. The readers must therefore consider first whether it is wise to restrict the term physiography to a single field, the lands. If so, what name should one give to the unified advanced study of man's fourfold physical environment, now commonly called physiography?

DYNAMIC GEOLOGY AND PHYSIOGRAPHY

As Glock points out, it is possible to study processes from the purely dynamic point of view, without taking account of the resulting land forms. Such studies have long been prosecuted, and have usually been considered a part of dynamic geology. Undoubtedly much more remains to be accomplished in this field. The only questions to be considered are whether it is wise to classify these studies in dynamic geology as a branch of physiography of the lands; and, if so, as to whether this branch should be called "geodynamics" instead of "dynamic geology." If the writer correctly understands Glock, there are no topics which would ordinarily be included in his geodynamics (where forms are not to be considered and where processes are to be viewed from the dynamic standpoint alone) which would not fall naturally and necessarily into the field of dynamic geology. Nor does geodynamics seem a less inclusive term than dynamic geology. If the two terms are essentially synonymous, this particular question is reduced to a choice between an older and a proposed newer usage.

On the more fundamental question as to whether purely dynamic geological studies should be classed as physiography, opinions may differ. Certainly some texts on physiography have so far emphasized the study of forces as to leave only secondary and partial emphasis on the study of the resulting forms. Not a few physiographers have voiced the criticism that such works are really treatises on dynamic geology rather than on physiography. Such criticism reflects the prevailing tendency to consider studies of processes from the purely dynamic point of view as lying outside the field of physiography, and to call such studies by the time-honored name "dynamic geology."

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[2] W. M. Davis, "The Progress of Geography in the Schools," First Year Book National Society for the Scientific Study of Education, Part II, pp. 7–49, 1902.

Physiography of the Lands and Geomorphology

For most workers in the subject, "physiography of the lands" and "geomorphology" are synonymous terms. Neither term implies the study of processes of and for themselves, any more than either implies the study of geologic structures of and for themselves. Such studies are left to workers in the classic fields of dynamic geology and structural geology. The physiographer (of the lands), or geomorphologist, does of course concern himself much with processes and structures, just as does the economic geologist, the stratigrapher and workers in other branches of geologic science. But he deals with both merely as factors in the evolution of land forms, which latter is the real object of his study. He touches lightly or leaves untouched many aspects of dynamic geology which are vitally important from the dynamic point of view, but which throw relatively little light on the evolution of the earth's surface features. So also in structural geology he is forced to pass by many fascinating questions which concern him less directly than other aspects of that field.

In short, the geomorphologist recognizes the existence and the importance of two vast fields, dynamic geology and structural geology, each well worth cultivating for itself alone, but each quite distinct in objectives, methods and in much of its subject matter, from his own field—physiography of the lands. From those neighboring fields he draws what he needs for the understanding of his special problems, just as he expects the dynamic geologist and the structural geologist to take from geomorphology everything which will help to elucidate their problems. But he does not forget that there is a real independence as well as an interdependence of the three fields of investigation.

The Nature of Geomorphology

The content of geomorphology is reasonably well established, both by definition on the part of experts in the subject and by common usage of workers in the field. It comprises the study of the origin and evolution of the surface features of the earth in terms of "structure, process and stage." Of the three terms of this trinity, elaborated by Davis in many of his writings, *structure* is the only static or passive element. The *process* is the active vitalizing factor without which there could be no cycle of land-form evolution; and the *stage* of the cycle is a transitory phase of the ever-changing record of the extent to which the active process has operated.

In a day when the only scientific geography was physical geography or physiography, it was perhaps natural that the cycle of land-form evolution should be called "the geographic cycle." To-day "geographic" has a very different connotation. Modern geographers may not agree as to the scope of their subject; but a large proportion of them define its essence, in one form or another, in terms of the relation of organic life to physical environment. The geographer thus puts emphasis not only upon life and its relations, but also upon physical environment as it is to-day. For him the physical environment may perhaps be said to represent the static or passive phase of his study. The cycle of land-form development is not "geographic" in this modern sense of the term. It is "geomorphic," however, and can perhaps best be called the *geomorphic cycle.*

Since the geomorphologist is dealing, in terms of structure, process and stage, with ever-changing cycles of land-form evolution, his point of view can never be static or passive. He studies the effects of geologic processes operating upon geologic structures throughout significant periods of geologic time. Only thus can he understand and interpret the evolution of the earth's surface features. Whether or not the dynamic geologist can afford to ignore surface form in his dynamic studies, it would seem that the geomorphologist must always think in terms of progressive changes effected by dynamic action.

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AN APPEAL TO ANTHROPOLOGISTS

Available information on the color of the iris at birth is meager and inaccurate. The popular generalization that "all white infants have blue eyes" is still widely quoted, although any obstetrician, midwife or nurse who has noticed the irises of many new-born infants can recall that some are totally brown, some are blue-green and some are mixed brown and blue or blue-green. It is well known also that during infancy significant changes in iris coloration occur, especially in those which are initially some type of blue. No positive information seems to be available as to whether the initially brown irises desaturate, and whether in the extremes of such cases they become finally some type of blue with or without partial brown patterns (in streaks, flecks or rings surrounding the pupil). Just how rapidly the major changes in coloration occur is unknown, although general opinion is to the effect that the "final" color is attained some time between the first month and the first year of post-natal life. However, general observation again suggests that throughout life marked changes occur. It is obvious that each of these factors must be considered in any adequate evaluation of the ethnological significance of iris color, as well as in any detailed study on the inheritance of this characteristic.

Through the cooperation of the department of obstetrics of the Johns Hopkins University, conditions favorable to the type of study just outlined have been placed at our disposal. Observations made so far present many new points of interest, which diverge from the commonly accepted opinions noted above. Moreover, problems have appeared which will call for a major series of investigations involving the cooperation of embryologists, oculists, chemists, physicists and others. By the end of the summer we hope to have a preliminary report ready, setting forth the import and complexity of the problem with the methods developed, and results of preliminary observations. In the meantime, we wish to invite the cooperation of anthropologists who are stationed in, or who plan expeditions to various parts of the world, in obtaining data on the iris coloration at birth, and on changes during the first year, for various stocks; especially those not available in the Eastern United States. Of special importance will be data on stocks which have been hybridized very little during recent times.

One of our ultimate goals will be the development of a scale which is both reproducible and graduated in more adequate steps of hue, saturation and pattern than any existing scale; and we are using methods by which our color standards can be specified in physical units; nevertheless, for present purposes, reports made in verbal terms will yield useful information. Descriptive terms such as those listed below, together with approximate descriptions of patterns due to intermixtures of color, are sufficiently differentiating to indicate variations of major importance. Such data are admitted to be unreliable, but where so little is known, rough data are indispensable to the planning of accurate measurements.

The following color terms include many of the differentiations of eyes at birth as so far observed, and are suggested as constituting the basis of a scheme which may give some uniformity of report for different observers. Of course, qualifying words may be needed in certain cases, and when the eye color falls outside of this list appropriate additional terms will need to be used.

Light yellowish brown
Dark yellowish brown
Light reddish brown
Dark reddish brown
Very dark brown

Light blue
Medium blue
Dark blue
Very dark blue
Gray blue

Light greenish blue
Dark greenish blue

Dark purple
Lavender

Pale red
Ruby red
Orange red

Special points to be noted are indicated by the following questions:

(1) Is the iris of approximately a single color evenly diffused?

(2) If the iris is a mosaic of two or more colors, what is the relative distribution and general character of the pattern; *e.g.*, does one color form a ring at the edge of the iris, or an irregular patch, or does it occur in flecks or streaks? What relative proportions of the iris are occupied by the various colors? An approximate description of the pattern would be desirable.

(3) At birth is the iris cleared, or is there a hazy coat of slaty blue or other color uniformly distributed; or is part of the iris thus covered, part of it being cleared and having another color? How early does the hazy coat disappear and the iris become cleared, and what is its color at this time?

(4) During the first few months do eyes which initially are totally blue change to brown, and do in some cases eyes which initially are brown change to totally blue or a smaller area of brown?

(5) What is the color of the sclerotic coat of the eye; is it "white" or is it bluish, brownish, etc.?

KNIGHT DUNLAP
W. C. BEASLEY

THE JOHNS HOPKINS UNIVERSITY

A FURTHER NOTE ON THE ANALYSIS OF ELECTROMYOGRAMS

IN a recent issue of SCIENCE, Davis, Forbes and Garceau[1] commented upon a method described by Travis and Hunter[2] for studying voltage-frequency relationships in action currents. Travis and Hunter may be criticized for not making clear certain points relative to the applicability of their method, but the method itself does not appear to deserve the criticism offered against it by Davis, Forbes and Garceau.

In the main Travis and Hunter's method is one for the treatment rather than for the elucidation of the origin and ultimate nature of action current potentials. It was designed to give an effective value for either regularly or irregularly appearing action current waves. However, it does not assume that the waves originally produced were made up of the frequencies revealed by the electrical analysis. The method appears to be an improvement over the practice of merely presenting and describing actual pictures of action currents. No physicist would venture to compare or describe waves from their pictures alone. He knows well that two waves may be quite similar pictorially but turn out to be very dissimilar when analyzed.

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[1] H. Davis, A. Forbes and L. Garceau, SCIENCE, April 22, 1932.

[2] L. E. Travis and T. A. Hunter, SCIENCE, February 19, 1932.

Although the method is certainly applicable to the study of repeating waves and much of value may be expected from such a study, it is the only means at our command now to evaluate quantitatively nonrepeating waves. Inasmuch as records of action currents either of many muscle or of many nerve fibers present irregular waves due to the combined asynchronous activity of many individual units some such method as that of Travis and Hunter is absolutely necessary if we are to have any reliable quantitative treatment of the action currents. Even if action currents from single units consist of repeating waves the voltage-frequency method could be used to good advantage. However, because very few pictures published of such action currents present absolutely periodic waves this method seems almost as necessary for the study of the electrical activity of a single unit as of many functional units. This is particularly true since the method of Fourier analysis can not be applied to waves unless the waves are absolutely periodic in form, frequency and amplitude. Such periodicity is the rare exception even in action currents from single units. Thus the statement of Davis, Forbes and Gareeau that a "Fourier analysis may be applied to the oscillograms of the individual impulses" is not generally true.

LEE EDWARD TRAVIS
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STATE UNIVERSITY OF IOWA

SCIENTIFIC BOOKS

The Wisdom of the Body. By WALTER B. CANNON, M.D., Sc.D., LL.D. W. W. Norton & Co., Inc., 1932, pp. 1–312.

THIS volume reads as though a college professor, with a mind rich in knowledge based on a lifetime of fruitful research in the laboratory, had set himself down upon his piazza in the cool evenings of the summer time and there recorded in simple but glowing language his thoughts concerning the facts and problems which had been uncovered by his life's work and were vibrating in his mind at the time. As to the language employed one might quote the fine description of the storage of water in the skin and in the muscles: "The entrance of water into these storage places appears to be a sort of *inundation.* I have already likened the lymph spaces to a swamp in which fluid stagnates. The analogy is implied also in the word inundation. We may think of the tissue spaces as being a sort of bog into which water soaks when the supply is bountiful and from which the water seeps back into the distributing system (the blood vessels) when the supply is meager." The use of lucid language of this sort justifies the author's expectation that the volume will be of interest not only to biologists but to the general reader as well. The book presents in comprehensible language the exquisitely sensitive regulatory mechanisms which maintain the units of the body in a state of nearly balanced equilibrium. Cannon terms this state "homeostasis," meaning thereby a condition which is relatively constant. The description of how homeostasis is maintained is accomplished without resort to complicated mathematical formulae but in straightforward talk of the obvious results of physiological experimentation.

In this manner the safeguarding of the fluid matrix is considered, and the homeostasis of the blood in regard to its content of water, of salt, of glucose, of protein, of fat, of calcium and of its neutrality of reaction. Also the regulation of body temperature is described. With great precision Cannon has revealed that the first action of exposure to cold is to cause a discharge of epinephrin into the circulation. This he determined by giving ice water to a cat the nerves of whose heart had been cut. Such a heart is very sensitive to an increased supply of epinephrin in the circulating blood, and an experimental application of cold, either internally as above or externally, resulted in a rapid increase in the heart rate. It is a matter of knowledge which we owe especially to Boothby that epinephrin increases the heat production, or in other words exerts a calorigenic action. In another place Cannon has called this increase of heat production through liberation of epinephrin from the adrenal gland the fine adjustment in the maintenance of body temperature, whereas shivering constitutes the coarse adjustment by which the heat production is increased to compensate for heat loss at the surface. The two factors, which were first clearly differentiated by Cannon, constitute the entity which Rubner called the "chemical regulation of body temperature" in contrast with the protection offered by the distribution of blood and the evaporation of water which constitute the "physical regulation of body temperature." Although Cannon has quoted generously from recent contemporaneous literature, the critic may perhaps be pardoned for asking why, of the older authorities, Claude Bernard alone should be the scientist freely cited. Perhaps, however, the charm of the book lies in the fact that it represents enticingly the view-point of a laboratory worker of rich experience speaking out of that fulness of personal knowledge, a method which compels interest in the subject and regard for the author.

In a final chapter Cannon discusses the possibility of the establishment of a "steady state" in the social and economic world. In this he follows the example of Aristotle in a celebrated passage which began, "The animal organism is to be conceived after the similitude of a well-governed commonwealth." Cannon suggests that the steady state of the fluid matrix of the animal organism indicates that the social organism should be provided with specially organized control over the processes of commerce. This would include the power to limit the production of goods so as to adjust the supply reasonably to the demand, the power to lay aside stores of goods and stores of wages and the power to arrange emergency employment. All these in a measure are represented as factors of safety in the human body. Perhaps one might suggest another analogy, which is, the fact that a human being, through undernutrition, may be brought to a level of maintenance of two thirds the quantity of food necessary for the normally nourished, even though at some loss of the sense of personal well-being. At a time when wheat is selling at the farm at 25 cents a bushel, in contrast with $2.20 during the war, it does not seem right that war-time wages should be practically guaranteed to railroad workers. Perhaps in times of economic distress the political leaders of Aristotle's "well-governed commonwealth" would have been so wise and so free from vote-getting ambition as to have decreed a reduction in railroad wages suggested by the 30 per cent. physiologically possible reduction in food calories, to the end that other wage-earners might be continuously employed. Into such seemingly fantastic analogies contemplation of the "Wisdom of the Body" leads us.

GRAHAM LUSK

The Universe Unfolding, By ROBERT H. BAKER, x + 140 pages. The Williams and Wilkins Company, Baltimore, 1932. $1.00.

THIS is an excellent book to be one of the volumes of the Century of Progress Series. The originality shown in the manner of presenting the astronomical facts will appeal alike to those who already know these facts, and to those who do not. It is a long way from the flat circular plane of the Greek's earth, over which bends the solid stationary dome of the sky, to the universe of galaxies and supergalaxies lying millions of light years beyond the solar system. However, the 140 pages of the book do cover this distance in a very satisfactory manner, and among these pages will be found the answers to many questions frequently asked by people in general about the modern methods of investigating the astronomical universe. This book can hardly fail to give any reader a better understanding and a greater interest in "the vast universe around us and the mysterious mind of man."

The first chapter tells of the universe as man in the past understood it, first according to the Ptolemaic system with the stationary earth at the center, and then according to the system of Copernicus with a central sun about which the earth and the other planets revolve. The second chapter takes up the story of the investigation of the sidereal system from the star gauges of Herschel to the statistical studies of Kapteyn, and then on to the work of the present day which has disclosed millions of vast stellar systems. The remaining chapters are devoted to the modern methods of investigating the structure of the universe. These describe the various methods of attack on this problem and tell the amount of success achieved by each method. The last chapter brings this interesting account up to the most recent discovery, which is that the exterior galaxies appear to have huge velocities of recession with respect to our own galactic system.

IDA BARNEY

YALE UNIVERSITY OBSERVATORY

SOCIETIES AND ACADEMIES

THE IOWA ACADEMY OF SCIENCE

THE forty-sixth annual meeting of the Iowa Academy of Science was held with Iowa State Teachers College at Cedar Falls on April 29 and 30, 1932, with 245 members and visitors in registered attendance.

The presidential address, "Our Underground Geology," was presented by Dr. James H. Lees, of the Iowa Geological Survey. Other papers of general interest were: "The Oxidation of Citric Acid," by Adrian S. Kuyper, of Iowa State University; "Some Observations on Spectral Color Discrimination," by Le Roy D. Weld, of Coe College; "The Effect of Preschool Attendance upon Intelligence Quotient," by Dr. Beth L. Wellman, of the Iowa Child Welfare Research Station; "The Iowa Conservation Plan," by

J. R. Crane, of the Iowa Fish and Game Commission. The annual academy lecture was presented by Dr. L. L. Thurstone, of the University of Chicago, on "The Measurements of Social Attitudes."

The Junior Academy of Science of Iowa met with the Iowa Academy at this time for its organization meeting. The following officers were elected: *President*, Henry Estabrooks, Dubuque High School; *vice-president*, Dwight Thompson, Des Moines; *secretary*, Genevieve Ostergaard, of Cedar Falls; and *treasurer*, Walter Brown, of Cedar Falls.

The officers of the academy and the chairmen of its sections for the forthcoming year will be: *President*, H. E. Jaques, Iowa Wesleyan College; *vice-president*, J. E. Guthrie, Iowa State College; *treasurer*, W. F. Loehwing, Iowa State University; *secretary and American Association for the Advancement of Science representative*, Joseph C. Gilman, Iowa State College; *editor*, Mrs. F. W. Nichols, Ames; *bacteriology and botany*, C. H. Werkman, Iowa State College; *chemistry, general and physical*, W. B. Zuker, Dubuque; *chemistry, organic and biological*, L. W. Sherman, Grinnell College; *geology*, J. E. Smith, Iowa State College; *mathematics*, L. M. Coffin, Coe College; *physics*, H. J. Plagge, Iowa State College; *psychology*, L. C. Douglass, Grinnell College; and *zoology*, E. R. Becker, Iowa State College.

The Academy convened in eight sections for the presentation of 133 papers of special interest. The retiring section chairmen made the following reports of their respective meetings.

Bacteriology and Botany: G. W. MARTIN, *chairman*. Of the thirty-one papers in the bacteriology-botany section eleven were concerned with bacteria and fungi in various relations and the remainder with botanical studies ranging from papers on mosses and ferns to those in the fields of morphology, cytology and taxonomy. An important feature of the program was the conference on the teaching of botany held on Friday morning, which was largely attended At the close it was voted to continue this phase of the meeting another year.

Chemistry: H. GREGG SMITH, *Chairman*. Among the papers presented before the organic-biological section were the following: "Vanillin Substitution Products with Acetophenone," by Gundy and Raiford; "Condensation of Furan, and Furan Arsenicals," by Henry Gilman and his students; "Reaction of Chloroamines with Zinc Alkyls," by Coleman and Andersen; and two papers on "Phenolic Ketimines," by Culbertson and his students. The biological papers included: "A Statistical Analysis of the Growth of Rats in the Stock Colony of the Foods and Nutrition Department of Iowa State College during the Years 1928–31," by Gladys Timson, Pearl P. Swanson and P. Mabel Nelson; "Vegetable Lecithin as an Antioxidant," by Kochenderfer and H. G. Smith; "A Study of Methods for the Determination of Reducing Sugar in Bacteriological Media," by McCreary and H. G. Smith. Of special interest was a report on 'The Rôle of Copper in Hemoglobin Regeneration," by Keil and V. E. Nelson, in which the importance of traces of copper was emphasized. The joint dinner of all the chemists was addressed by Drs. Raiford, Knight, Bartow and Petersen.

Geology: E. J. CABLE, *Chairman*. The Geology Section of the Iowa Academy of Science which met at Cedar Falls, Iowa, on April 29 and 30, had a most interesting and profitable meeting. Papers representing stratigraphic, paleontologic and Pleistocene geology were ably presented and discussed. Some of the more outstanding papers were, "Interpretation of the Relationships of Iowan Drift," "The Peorian Loess," and "The Wisconsin Drift from Recent Studies in Iowa and Illinois"; "The Upper Devonian Beds in Iowa County," "Sedimentation of the Cedar Valley Limestone"; "The Cedar Valley Limestone at Gloria and Waterloo, Iowa"; "Interglacial Mammalian Remains"; The Story-Hamilton Artesian Area"; "Discussion of the Section of the United States from Lake Superior in Wisconsin to Oklahoma," prepared by the Kansas State Geological Society; "Ice Caves," and several other papers of less importance.

Physics: T. C. POULTER, *Chairman*. A group of twenty-one papers, covering a number of very interesting topics was presented and discussed in the Physics Section meeting of the Iowa Academy of Science. Several papers were presented in the Friday afternoon session followed by the Physics dinner at the Tip Top Tavern. Following the dinner a very interesting and inspiring lecture was given by Dr. C. J. Lapp, of the Department of Physics, University of Iowa, on "The Structure of the Nucleus." This lecture was well illustrated by lantern slides. A vast amount of recent information was presented on the most fascinating topic in modern physics. The remainder of the papers were presented at the Saturday morning session, following which Dr. H. G. Plagge, of Iowa State College, was elected chairman of the Physics Section for the coming year.

Psychology: THOMAS F. VANCE, *Chairman*. Among the eight sections of the Iowa Academy of Science, Psychology ranked third in the number of papers presented at the 1932 meeting. The eighteen papers may be classified as follows: General 3, educational 7, child 3, tests and measurements 4, and industrial 1. Space does not permit the listing of the papers presented but they will be published either in full or by abstract in the "Proceedings" of the academy. This year the academy's evening lecture was in the field of psychology, Dr. L. L. Thurstone being the speaker on the subject, "The Measurement of Social Attitudes." Dr. Thurstone also spoke to the psychologists assembled at dinner on the subject, "Modern Psychophysics."

Joseph C. Gilman,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW HYDROGEN ELECTRODE AND APPARATUS FOR THE DETERMINATION OF pH

It is known that, in order to measure the pH of liquids containing CO_2 in solution, such as blood, serum, tyrode solution, etc., it is necessary to prevent the escape of CO_2 which would result in an erroneous reading. Furthermore, Hasselbach and Clark have shown that it was necessary, in order to obtain reliable and stable measurements, to keep the platinized-platinum electrode successively in contact with the liquid and with the atmosphere of hydrogen. This is obtained, in the well known Clark's electrode, by shaking the vessel by means of an electric motor. This method can be considered as standard and yields excellent results. However, it requires rather large quantities of serum or blood (6 cc), and the time necessary to reach the equilibrium is long. Besides, the apparatus, entirely made of glass, incorporates four glass stopcocks, rubber tubing, clamp, and does not lend itself to an easy temperature control.

We have recently worked out an hydrogen electrode in which the equilibrium is reached in about one minute, for ordinary solutions, with less than one cc of liquid. The principle is different from that of Clark's electrode as it is based on the permanent rotation of a tilted electrode in the shape of a disk, one half of which dips in the liquid, the other half being in the hydrogen. During its rotation, a thin layer of liquid carried by the disk is constantly brought in contact with H_2 and, as the rate of rotation may be as high as 500 revolutions a minute, the saturation takes place in a very short time. The readings are taken while the electrode is in motion, and are very constant. It is useless to say that all sorts of shapes can be used for the platinum electrode: spiral, screw propeller, etc. Of course, a proper technique is used to fill the cup with the serum and introduce H_2 with the minimum possible loss of CO_2. (Fig. 1). Practically, a glass syringe is used: the platinum disk is fixed to the piston, and the liquid-liquid junction is established through a capillary tube. One or two hydrogen bubbles are sufficient.

In order to simplify the handling and to reduce the chances of breakage, we have the whole apparatus (hydrogen and calomel electrodes stand) made of metal (see Figs. 2 and 3), the only glass parts being the syringe and the calomel electrode. Both hydrogen and calomel electrodes are water-jacketed and may be taken apart in a few seconds. No glass stopcocks, nor expensive glass parts are used. No troublesome diffusion was observed in one hour.

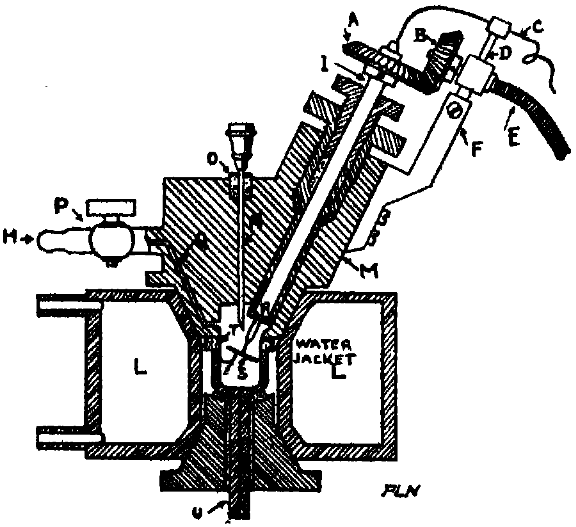

Fig. 1

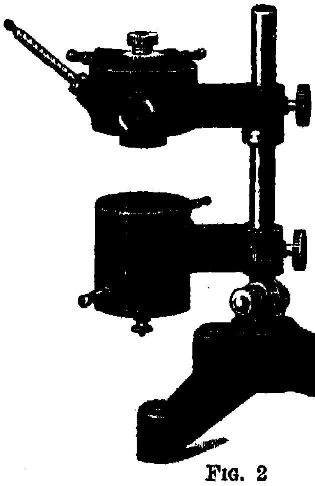

Fig. 2

When this instrument is used to determine the pH of ordinary solutions, the rotatory electrode is no longer absolutely necessary. It may then be replaced —and the change is done instantaneously—by a simple platinum tube, through which the hydrogen is allowed to bubble gently in the liquid. In this way, the equilibrium is also attained in an amazingly short time, and the readings take place while the bubbling goes on.

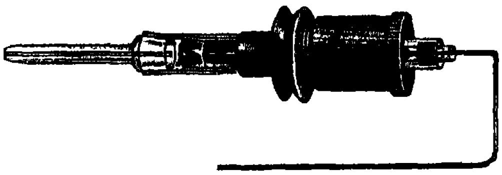

FIG. 3

As will be seen on the figure, the contact between the two half cells is established by raising the lower (calomel) cell until the capillary end of the syringe dips into the KCl.

The calomel element consists simply of a short test-tube, about 18 mm in diameter, with a platinum wire sealed at the bottom. When slipped in place in its water-jacketed stand, it rests on a rubber ring, the platinum wire touches a drop of mercury and the contact is established. The saturated cell may be replaced by others (Normal, 1/10th Normal), in two seconds.

Of course, the principle of the tilted rotatory electrode can be applied in different ways. For example, a simple model can be made by having the electrode and the vessel containing the liquid and H_2 connected through a rubber stopper, the whole being then rotated around its axis at such an angle that will allow the liquid to cover about one half of the electrode.

This apparatus, whether used with the simple tubular electrode for ordinary solutions, or with its tilted rotatory electrode, lends itself particularly well to measurements in series, as the setting up, filling of the syringe, saturating with H_2, and measuring the E.M.F. never takes more than five minutes with ordinary solutions.

P. LECOMTE DU NOÜY

INSTITUT PASTEUR

A METHOD OF RELACQUERING THE STEMS OF LIVINGSTON ATMOMETER BULBS[1]

IN the course of certain ecological work in the Hawaiian Islands, it was found that the lacquer on the stems of some Livingston atmometer bulbs began to peel off after about six months' service in the field, and the writer was requested to make repairs on these bulbs. The exact cause of this peeling was not determined, but it was believed to be due to over-liberal use of alcohol, used to sponge off the bulbs to prevent algal growth.

Attempts to relacquer with ordinary white shellac proved quite unsuccessful, but after several trials with various mixtures, the following proved very satisfactory.

To 100 cc of prepared white shellac (already dissolved in alcohol), add 30 to 35 cc of absolute alcohol, and shake. To this stock add 30 to 35 cc of fresh Canada Balsam (not the histologist's preparation dissolved in xylol, but the fresh liquid balsam as purchased from a druggist) and mix well.

The bulbs to be repaired are then thoroughly dried out, and all old lacquer removed from the stems with a razor blade. In effecting this removal some care must be used not to damage the surface of the stem more than necessary, since such abraded patches are very absorbent and difficult to relacquer.

The stems are then painted with a thin coat of the above mixture and allowed to dry in a warm room, but *not in an oven,* and when dry are given a second or even a third coat, until when dry, the whole stem has a shiny and polished appearance.

SUMMARY

A method of relacquering the stems of Livingston atmometer bulbs by the use of a mixture of white shellac and Canada Balsam is outlined, together with certain precautions to be observed in the process.

JOHN STANLEY

SPECIAL ARTICLES

THE APPARENT PREPOTENT FUNCTION OF THE ADRENAL GLANDS[1]

ACCUMULATING evidence indicates the direction in which solution of the adrenal enigma may be found. The Harvard school of workers led by Cannon have in the last decade delivered a veritable broadside of reports on medulliadrenal activities, and almost universal support of their findings has been forthcoming. Emergency functions which are subserved through medullary agency appear to be established.[2] Observations by Cori and his colleagues direct attention to the importance of carbohydrate changes wrought particularly through the influence of adrenalin.[3] Early work by one of us on the adrenal medulla has related this tissue to the metabolism of carbohydrates.[4]

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[1] Reported *in extenso* at a meeting of the University of Virginia Medical Society, January 18, 1932.

[1] Published with the approval of the director as Miscellaneous Paper No. 12 of the Experiment Station of the Association of Hawaiian Pineapple Canners, University of Hawaii.

[2] W. B. Cannon, "Bodily Changes in Pain, Hunger, Fear, and Rage," 1929.

[3] C. F. Cori, *Physiol. Rev.*, 11: 143, 1931.

The recently devised methods of preparing effective extracts of the adrenal cortex have opened new approaches and allowed rapid advances in a phase of the subject generally acknowledged to be most difficult. For this development great credit is due to Swingle and Pfiffner[5] and to Hartman and his colleagues.[6]

Three years ago investigations were taken up in this laboratory on the nature of cortico-adrenal activity. Preliminary results strongly suggested a relationship of the adrenal cortex to carbohydrate metabolism in the organism. Further experiments in this[7] and other laboratories have indicated, however, that possibly protein metabolism and also renal and sexual activities may be governed by the cortical tissues.

Workers at Princeton and Johns Hopkins[8] have attributed considerable importance to the marked changes in renal secretion which follow adrenalectomy and the amelioration which is brought about by the administration of cortico-adrenal extract. The augmentation of blood urea in adrenal insufficiency, and the reduction effected by the extract, are also believed to be of outstanding significance. In a previous report[7] we have pointed out that such effects are probably indirect or secondary to more fundamental changes. Renal activity appears to follow the general and circulatory conditions in adrenal insufficiency. Animals which have died from adrenal deprivation do not show any significant alteration in kidney tissue; frequently, indeed, no pathological change has been observed in our experiments.

It can hardly be considered that the accumulation of unutilizable protein end-products in the body or the diminution in kidney secretion represent preeminently *critical* conditions in the adrenalectomized animal. Nor can it reasonably be entertained, furthermore, that precocious sexual developments which are observed to be brought about by cortical extract,[9] interestingly significant though they may be, reflect the *primary* activity of the adrenal cortex. That the effects on the sexual organs probably indicate the activity of a hormone of a second-class order, which is present in the crude extract, has been postulated. The essentially important cortical function must evidently be sought in other directions.

Apparently convincing testimony of the profound and possibly primary involvement of the adrenal cortex in the regulation of carbohydrate metabolism is now briefly presented. Cortico-adrenal extract prepared in this laboratory according to the method of Swingle and Pfiffner[5] has been employed.

Adrenalectomized animals (cats) have been found to suffer progressively severe derangements in carbohydrate metabolism following the operation. The glucose in the blood and the glycogen in the liver become profoundly reduced, the latter sometimes almost to the disappearing point. Muscle glycogen is greatly diminished, while the blood lactates are increased. The carbohydrate changes which we have observed in cases of experimental adrenal insufficiency are revolutionary enough in themselves to bring about death of the animal. Serious reductions which occur in the blood sugar and hepatic glycogen values appear to be of the greatest significance.

The administration of extract of the adrenal cortex to animals showing symptoms of adrenal insufficiency produces a remarkable reversal of the above disordered conditions. The liver and muscle glycogen and blood sugar levels are increased and the lactic acid values are concurrently decreased to the normal limits. The chemical changes appear in coincidence with the return of the animal to normal activity, *i.e.*, in the few hours following intraperitoneal injection of the extract.

Adrenalectomized animals which are obviously in a terminal dying condition, and which are known to be suffering crucially from glycogen depletion, may be completely recovered by the extract. Adrenalin given in dilution equal to that usually found in the cortico-adrenal extract used does not bring about similar restoration of the animal or such noteworthy carbohydrate changes.

The table herewith presents in summary our experimental results. The average muscle and liver glycogen values of the treated animals (series IV) are increased about threefold and twentyfold, respectively. it may be noted, in contrast to the values found in untreated adrenalectomized animals (series II).

Comparison has also been made of the effects of glucose injections in normal and adrenalectomized cats. In such experiments, large amounts of glycogen were found to be stored by unoperated animals, while those without adrenals showed relatively small glycogen changes from the previously observed low levels.

It is recognized that all theories of adrenal function are at present inadequate. The emergency theory offers an admirable interpretation of the mode of medulliadrenal activity, but knowledge of cortical function has been shrouded in conjecture up to the present

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[4] S. W. Britton, *Amer. Jour. Physiol.*, 74: 291, 1925; *Physiol. Rev.*, 10: 617, 1930.

[5] W. W. Swingle and J. J. Pfiffner, *Amer. Jour. Physiol.*, 96: 153, 1931.

[6] F. A. Hartman, K. A. Brownell and W. E. Hartman, *Amer. Jour. Physiol.*, 95: 670, 1930.

[7] S. W. Britton *et al.*, *Amer. Jour. Physiol.*, 99: 9, 15, 33, 44, 1931.

[8] G. A. Harrop *et al.*, *Anat. Record*, 51: 39, 1931.

[9] E. L. Corey and S. W. Britton, *Amer. Jour. Physiol.*, 99: 33, 1931.

TABLE SHOWING GLUCOSE, GLYCOGEN, AND LACTIC ACID LEVELS UNDER VARIOUS EXPERIMENTAL CONDITIONS

Series No.	No. cats used	Experimental conditions	Muscle glycogen average per cent.	Liver glycogen average per cent.	Blood sugar average per cent.	Blood lactic acid average per cent.
I	5	Normal, fasted 48 hours	.432	1.480	.112	.025
II	9	Adrenalectomized, untreated	.208	0.067	.048	.038
III	5	Adrenalectomized, adrenalin treated	.392	0.276	.051	.031
IV.	8	Adrenalectomized, extract treated	.585	1.305	.097	.026
V.	6	Normal, fasted 48 hours, glucose treated	.336	2.120	.137	.025
VI.	5	Adrenalectomized, glucose treated	.398	0.275	.206	.035

time. That the cortex in contrast to the medulla is of premier importance in the bodily economy has, nevertheless, been long appreciated.

The adrenal glands are indispensable in the maintenance of life processes. Considering their size they are possibly the most important chemical factories in the body. Extirpation of the organs brings about death in a few days. After pituitary, thyroid or parathyroid removal life may be maintained for many weeks or months, or even indefinitely in some cases. The remarkably rapid dissolution following adrenalectomy is due specifically to cortical loss.

Even in the severest conditions of inanition and exposure of animals to cold, in death from insulin or strychnine convulsions, and in experimental diabetes, the hepatic and muscle glycogen values are not often found to be reduced beyond the low levels which we have observed in adrenal insufficiency. The muscle glycogen and blood glucose in hepatectomy are not depleted more thoroughly than in the case of animals dying from adrenal extirpation. And in hepatectomy as well as pancreatectomy death is admitted to be due primarily to carbohydrate deficiency.

The results given herewith indicate that the severity of the carbohydrate changes in adrenalectomized animals is fully sufficient to produce death. This eventuality is readily averted by cortico-adrenal extract administration, which results in rapid restoration of the normal blood glucose and liver and muscle glycogen values. A serious incompetence in storing injected glucose has also been noted in animals without adrenal glands. The cortex is indispensably important in maintaining, in cooperation with other organs, the normal metabolism of carbohydrates. This apparently represents the prepotent function of the adrenal cortex in the organism.

Possibly the primary defect in adrenalectomy is to be found in failure to store liver glycogen. Adrenal insufficiency may perhaps be considered in synonymity with glycogen insufficiency.

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SOME EFFECTS OF OVARIECTOMY UPON BREEDING FEMALES

IT has previously been observed[1] that the secretions of the ovaries play an important part in the preparation of the mammary tissue of mice for the inception of the cancerous condition.

In a closely inbred strain of mice with a high incidence of breast cancer, it has been found that the age at which the appearance of the tumors was first noted follows a very regular unimodal curve which starts at four months, has its peak at eleven months and extends to the twenty-second month. The lower range of the standard deviation from the mean (11.6) of this curve falls in the 8th month. From this it is evident that the great majority (80–90 per cent.) of the females which are destined to develop cancer of the breast will do so between the seventh and fifteenth months.

The present experiment was conducted in an attempt to determine whether or not the high incidence of tumor in this strain is in any way controlled by ovarian activity.

Breeding females were separated from the males at seven months of age and were ovariectomized. They were then allowed to grow old under the same conditions as the control breeders. An equal number of breeding females were separated from the males at this same age and kept under similar conditions without operation, as controls.

There were then three distinct classes of animals in the experiment:

(1) Normal breeding females.

(2) Ovariectomized females which had been used as breeders for seven months.

(3) Females that were used as breeders for seven months and then separated from the males.

In the first class there were 1,938 females which lived to be over seven months of age. Of these, 1,275, or 65 per cent., died of cancer of the breast.

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[1] Porter Fellow of the American Physiological Society.

[1] W. S. Murray, "Ovarian Secretion and Tumor Incidence," *The Journal of Cancer Research*, Vol. xii, No. 1, March, 1928.

In the second class there were 195 animals. Of these 78, or 40 per cent., died of cancer.

In the third class there were 198 animals, 140 of which, or 70 per cent., died of cancer.

It is evident from the above that ovariectomy of breeding females at seven months reduces, markedly, the incidence of mammary cancer.

TABLE I

EXPECTATION OF LIFE

Age in months	Breeding females	Control females	Operated females
7–8	4.4	4.6	6.2
8–9	3.5	4.1	5.8
9–10	3.0	3.3	5.6
10–11	2.6	2.9	5.5
11–12	2.3	2.4	5.7
12–13	2.1	2.0	5.8
13–14	1.9	1.6	6.0
14–15	1.8	1.5	5.8
15–16	1.7	1.5	5.6
16–17	1.5	1.3	4.8
17–18	1.3	1.1	4.3
18–19	1.3	.7	4.5
19–20	1.2	.5	4.2
20–21	1.0		3.7
21–22			3.5
22–23	1.0		3.4
23–24			3.3
24–25			3.3
25–26			3.0
26–27			2.0
27–28			2.5
28–29			1.5
29–30			1.0
30–31			.5

If the expectation of life[2] (in months) is computed for the breeding females of this stock, regardless of the cause of death (Table I, Column 1), it is found to be 4.4 at seven months and falls in a steady curve to 1 when the mice are twenty-two months old.

If the expectation for the control females is computed in the same way, it is found that the curve closely approximates that of the breeding females but ends two months earlier.

The expectation curve for the operated animals is markedly different. Starting at 6.2 months, it falls off for four months, rises again until it reaches six at the thirteenth month, and then ranges gradually downward to .5 at the thirtieth month. This indicates that ovariectomy of breeding females during the seventh month not only prolongs the lives of some individuals in a marked degree but delays death among them so generally that at 17 months they have the same (or greater) expectation of life as do the breeding females at 7 months.

It appears from these data that ovariectomy of breeding females approaching the cancer age protects them to some extent against as early death as they would have had without operation.

That it also protects them in some degree against cancer of the breast may be seen from Table II.

TABLE II

PER CENT. OF THOSE DYING IN EACH AGE PERIOD, WHICH HAD MAMMARY CANCER

Age in months	Breeding females	Control females	Operated females
7–8	34	25	22
8–9	43	64	52
9–10	56	73	38
10–11	64	100	38
11–12	72	69	52
12–13	83	80	73
13–14	84	85	40
14–15	77	75	50
15–16	77	67	50
16–17	91	100	40
17–18	91	50	27
18–19	93	0	60
19–20	83		50
20–21	75		60
21–22			20
22–23	100		0
23–24			0
24–25			0
25–26			0
26–27			0
27–28			0
28–29			0
29–30			0

Here it is demonstrated that the percentage of those dying of cancer in each age period is appreciably higher in the breeding females and controls. It is shown that all the ovariectomized females in this experiment which live to be more than 22 months old are completely free from cancer.

To summarize: The influence of the ovary on the incidence of mammary cancer is, in this stock of mice, clearly established. It is sufficiently striking so that it may be demonstrated by removal of the ovary from breeding females seven months old. The removal of the ovaries greatly increases the expectation of life and decreases the incidence of mammary cancer.

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[2] Raymond Pearl, "Medical Biometry and Statistics," W. B. Saunders Co., Philadelphia, 1930.

GROWING COTTON AND OTHER CROP PLANTS WITH AMMONIUM NITROGEN[1]

Willis and Rankin[2] grew cotton seedlings in soil in which had been added cottonseed meal in a concentration equivalent to 16 pounds of nitrogen per acre. Associated with the application of cottonseed meal, there occurred definite injury to the roots. They attributed this injury to "ammonia toxicity." This interpretation of their results accompanied by considerable publicity has led to the erroneous idea that ammonium fertilizers are toxic to cotton plants. Their *results do not warrant such a generalization.* These results were apparently obtained under conditions where the soil buffer system was inadequate. They added calcium sulphate and the cotton seedlings were not injured. Calcium sulphate may have acted as an adsorbent, and, thereby, prevented the hydrogen-ion concentration from becoming too high or too low for the welfare of seedling roots.

The conclusion that ammonia is toxic is not in harmony with results secured by Tiedjens and Robbins[3]. They grew various plants with sulphate of ammonia and ammonium hydroxide at pH values of 7–8.8; tomato and soy-beans were supplied with sulphate of ammonia in sand cultures, and good growth was obtained, but the plants exhibited even more luxuriant growth when supplied with ammonium hydroxide. Growth was comparable to that of good field-grown plants, and equal or superior to that of others in sand cultures, which received all their nitrogen from calcium nitrate.

Cottonseed meal, as employed by Willis and Rankin, *for some reason produced injury to cotton seedlings.* The interpretation of these workers would imply that the cotton plant is peculiarly sensitive to extremely low concentrations of ammonia nitrogen. Since the publication of their data, cotton has been grown by the author in sand cultures from the seedling stage to the opening of the bolls, with sulphate of ammonia, ammonium hydroxide and calcium nitrate, respectively. Ammonium hydroxide was supplied in a complete nutrient solution at pH 8. At no time was there any indication of injury to the plants, even though there was a perceptible odor of ammonia coming from the ammonium cultures. At the present time, these plants are five feet high, profusely branched, and producing flowers which have resulted in numerous bolls, which are beginning to open. If there is any superiority between the two forms of nitrogen, it is in favor of the ammonia cultures.

The concentration of nitrogen as ammonia in these cultures was higher than that of the total nitrogen in the cottonseed meal, which was employed by Willis and Rankin,[2] and which they state was toxic to cotton plants on account of the free ammonia liberated.

Tomato, soy-bean and cotton can adsorb ammonia over a wide range[4] of pH (3.5–8.0), but these plants will not assimilate the ammonia[5] (synthesize simple proteins from ammonia), unless, when supplied to the plants, the pH of the nutrient solution is above 6. When conditions are unfavorable for assimilation of ammonium nitrogen, it may accumulate in the plant to a considerable concentration. It does not injure the plant any more than does the accumulation of nitrate nitrogen. Nitrates may also accumulate in the plant in large quantities, when reducase activity[5] is limited.

If a nutrient solution containing nitrogen as ammonium only is supplied to a cotton plant at pH 3.5, no perceptible growth is made, even though some ammonia is absorbed. If the pH is raised to 7.5 or 8, perceptible growth takes place in 48 hours.

Holly, Pickett and Dubin[6] grew cotton in solution cultures in which their solutions were supplied to the plants at pH 6. They report a larger volume of growth for the nitrate plants. The appearance of the ammonium supplied plants resembled those grown by the author at pH 6.5. This pH value was found to be too low in sand cultures for maximum elaboration of ammonium nitrogen in cotton.

The fact that injury did not result from the accumulated ammonia and that growth took place soon after shifting to the higher pH seems sufficient proof that ammonia is not more toxic than other nutrients. The results of Willis and Rankins are valuable in that they show the importance of a buffer system in sandy soils where incomplete fertilizers are used. The generalization that ammonia is toxic to plant growth, under good cultural conditions, is no longer tenable.[4]

Victor A. Tiedjens

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[1] Journal Series, paper of the New Jersey Agricultural Experiment Station, Division of Horticulture.

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SCIENCE

VOL. 75 FRIDAY, JUNE 24, 1932 No. 1956

Upsetting the Balance of Nature, with Special Reference to Kansas and the Great Plains: PROFESSOR ROGER C. SMITH 649

Viruses: DR. T. M. RIVERS 654

Obituary:
Thomas H. Gronwall: DR. J. F. RITT. *Ellen Churchill Semple*: DR. WALLACE W. ATWOOD. *Memorial to Dr. John Briquet*: E. D. MERRILL 657

Scientific Events:
Birth Rates and Death Rates; Investigation of the Woods of the World; Government Controlled Forest Lands; The American Society of Agricultural Engineers; The International Cancer Research Foundation; Retiring Members of the Faculty of the Massachusetts Institute of Technology 658

Scientific Notes and News 661

Discussion:
An Experiment in Teaching Public Health Zoology at Rollins College: DR. C. W. STILES. *Regarding the C Forms of Kuhn*: DR. PHILIP HADLEY. *Whaling in Northeastern Japanese Waters*: MILES L. PEELLE 664

Scientific Books:
Rydberg's Flora of the Prairies and Plains of Central North America: DR. FRANK C. GATES 667

Societies and Academies:
The Ohio Academy of Science, 1932: W. H. ALEXANDER. *The Tennessee Academy of Science*: DR. JOHN T. MCGILL 668

Scientific Apparatus and Laboratory Methods:
A Convenient Method of Photographing Small Animals at Low Magnification: DR. ROMAN KENK. *Permanent Preservation of the Human Body by Infiltration*: EDMOND J. FARRIS 669

Special Articles:
General Theorems in Dynamics: PROFESSOR EDWARD KASNER. *Soil Weights before and after Dispersion*: L. B. OLMSTEAD and DR. HORACE G. BYERS 671

Science News 8

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UPSETTING THE BALANCE OF NATURE, WITH SPECIAL REFERENCE TO KANSAS AND THE GREAT PLAINS[1]

By Dr. ROGER C. SMITH

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A HUNDRED years ago, the great plains were still largely in their primeval state. A balance of biological life or of organic groups had been set up through the ages and this balance probably then was but little disturbed. The land at that time was in permanent sod. This sod, in Kansas, was made up largely of some 40 species of grasses out of the known 372 species of the state. The plains probably were burned off every few years by fires, started by the Indians or by lightning. In the valleys and gullies, a few scrubby oaks and cottonwoods, honey locusts and elms had escaped the fires and were maintaining a rather difficult existence. Herds of bison roamed the prairies, but they disturbed the vegetation little, since they did not stay long in any one place. Rattlesnakes, bullsnakes, coyotes, wolves, hawks and owls preyed largely upon the rabbits, ground birds, pocket gophers and prairie dogs. Great flocks of carrier pigeons roosted in the trees and, together with prairie-chickens, sage hens and bob-whites, fed upon berries, the seed of many weeds and grasses and many kinds of insects. Swarms of grasshoppers came occasionally, and no doubt at least partly defoliated the grasslands and the trees, but they were dealing with perennial plants then and these withstood the onslaughts of the hoppers.

About one hundred years ago the scene began to change, slowly at first but profoundly, nevertheless.

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[1] Contribution No. 399 from the Department of Entomology, University of Kansas.

[2] Presidential address, delivered before the Kansas Academy of Science, McPherson, Kansas, on April 5, 1932.

Man, that great disturber of natural balances, came to this area, sometimes called the "Great American Desert," to establish homes and to wrest a living out of this virgin soil. He killed, often for pleasure, the bison, prairie chickens, sage hens, carrier pigeons and most of the snakes. He brought with him cattle to fatten and multiply on these fertile plains. He brought tools which tore up the aged sod, after which he planted some other grasses, such as corn, wheat, oats, rye, barley and sorghums. These plants were annuals, however, and far more delicate than nature's crop. This process which has continued to the present, has caused the great plains to lose more and more their old identity. Areas of virgin sod are not extensive now, except on the hill tops, which are good for little, agriculturally, but permanent pasture. Intensive grazing, even of these areas, has largely changed them from their primitive conditions. Prairie fires are no longer a factor, and Kansas to-day is one of the few states in the Union which has more trees than when it was settled.

Within the memory of the older residents, badgers were plentiful in Kansas. These animals are almost wholly insectivorous and helped to check the ancient pests of the still more ancient sod. Badgers are now very scarce in this state. The beaver likewise was fairly plentiful in the state, but they became a rarity before horseless vehicles appeared on the highways.

These profound changes have been accompanied by a recognizable series of biological phenomena which might be expected to follow, upsetting this ancient harmony among living things. It is my purpose to point out, not only some of the evidences, chiefly among our insect problems, of this unbalanced condition in nature, but also to offer some explanations for present wide fluctuations and to point out some of the forces working towards the establishment of a new balance.

The phrase, "balance of nature," is used to define that relative constancy of numbers of plants and animals over a long period of years, such that fluctuations in numbers ordinarily occur within relatively narrow limits only.[3]

One can not discuss animal populations without considering plant associations also, for the whole is a biological complex of the most intricate associations, as many writers have pointed out. The plant ecologists refer to this balance or complex among plants as "climax formation."[4] I shall, however, discuss animals primarily and refer to plants only somewhat incidentally.

The annual population in nature of any short-lived plant or animal can be represented, not by a straight line, but by a narrowly undulating line about a straight line expressing a general average. Outbreaks are periods of excessive numbers which indicate that the species is out of balance. The food supply, weather and other natural checks must have been very favorable for excessive increase of the species. In the ideal balanced or stabilized natural environment, outbreaks would not occur, though there would be fluctuations in numbers due to changes in weather conditions from year to year.

The plowing up of the native sod and planting present-day crops were the first and most important steps in this balance upset. It gave the then existing native species of animals new food plants and, in many cases, supplied them with a habitat nearer their optimum than nature had provided.[5] The natural result was an increased rate of reproduction with a consequent increased population of the species. Furthermore, it appears that the parasites of some of the more important insect pests require a period of years to adapt themselves to a new plant occupied by their host. This, no doubt, has been a factor in the relative unimportance of parasites in the effectual checking of most economic insects in the great plains region up to the present time. The wheat stem sawfly, for example, is said to be more heavily parasitized in wild and in other cultivated grasses than in wheat.

The change in the native flora of the prairie region is apparent to all. The fauna has been equally affected by agricultural development, insects and the smaller forms being somewhat less affected than the higher forms.[6]

Most plants and animals of the Great Plains exhibit more or less striking modifications for living there. Time does not permit a cataloging of the more striking adaptations, but many of them are common knowledge. One needs only to think of the adaptations of the grasses, tumbleweed, sunflower, cocklebur, ragweeds, of coyotes, jack-rabbits, pocket gophers, prairie-dogs, prairie-chickens and of the prairie snakes to their native habitat. The insects of the prairie have many structural adaptations which fit them for prairie life. Among these are the heavy integument of the wireworms and false wireworms, and the modifications for burrowing of many insects. These same modifications have made them all the more serious as pests of man's food plants.

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THE GROWING OF WHEAT AND ITS EFFECT ON SOME GRASS-FEEDING INSECTS

The soil and climate of the Great Plains were early found to be well adapted to the growing of wheat. The 44-year mean annual rainfall of 27.1 inches for the whole state of Kansas is sufficient for the crop. This rainfall comes in the growing season, while the winters are usually dry with moderate temperatures. Splendid native soil fertility has made it possible in the great plains states to grow wheat in great quantity and of high quality. The large acreages and yields of the great plains states attest to the adaptation of this crop to the soil and climate of the region. It is sometimes called the "world's bread basket."

About the year 1775, an insect known as the Hessian fly (*Phytophaga destructor* Say) was accidentally introduced into the United States, presumably in straw brought over from Europe by Hessian soldiers. This creature found the opportunities in America to be all that had been said of them. The Hessian fly was a natural feeder on wheat, barley and rye in Europe, and on some of the wild grasses. Wheat, an annual grown in large acreages and a more succulent grass, is more to its liking than wild grasses. The climate of the great plains suited this creature perfectly. While in its native home it had to be content with one or two generations a year; in Kansas it could, with only rare exceptions, always have two or three generations and could in favorable seasons often produce four or five generations. Enemies were not very important factors. They could not keep up with such reproductive speed anyway, so we have in the Hessian fly an enemy of major importance to wheat. It may have changed its food plants to one of man's crops as the years have rolled around, but its environment has been changed to nearer its optimum. Nature's forces to maintain it within narrow limits of fluctuations have not yet proved effective.

As the years go on, natural enemies of the Hessian fly, aided by man, may be expected to increase in number, and probably in importance. Varieties of wheat resistant to this pest are now realities. Not to be outdone, however, the Hessian fly has appeared in strains peculiar to communities and to varieties, so it is prepared, as it were, to meet this new move.[7] It is the old contest over again between the safe-maker and safe-breaker. Man's reliance on this crop for food forces him to engage in genuine combat with the Hessian fly and to assist mother nature to force this pest into a condition of relative obscurity, as it must have been when its food, in prehistoric times, was native grasses and wild rye in Europe.

The false wireworms (*Eleodes* spp.) fed on weed seeds in the days of the old prairie. It was a short step to devouring the germinating wheat kernels in the dry soil when germination was delayed. To-day the false wireworms are major pests in the western half of Kansas and over much of the great plains region. Their adaptation to hard living conditions before man came here makes them most difficult to control.

The army cutworm (*Chorizagrotis auxiliaris*) is one of the best examples of a native grass-feeding insect which has lately become a serious enemy of many Kansas crops, including wheat, alfalfa, corn, oats and gardens. This insect is well equipped for life on the prairies. It feeds at night or during the afternoons of cloudy days. During the warmer part of the day it hides beneath the surface of the soil or trash, thereby reducing the danger from parasitism. When the brood has destroyed the vegetation in a field, it marches as an army, to an adjacent feeding ground. Observations have indicated that this species estivates in the adult stage (and probably in the larval stage also) during the hot summer, an adaptation to the high summer temperatures of the great plains area.

SOME NATIVE PRAIRIE INSECTS BECOME PESTS OF CULTIVATED CORN

Then the pioneers brought corn from Ohio and the New England states. This is another grass. It grew well in the valleys and served particularly for feed for domesticated animals. A little creature called the chinch-bug (*Blissus leucopterus* of the family *Lygaeidae*) now believed to be a native inhabitant of the great plains, found several of man's crops very much to its liking. It is significant that this insect returns to the bunch grass, its probably original or native food plant, to pass the winter. The chinch-bug spread with the growing of corn, oats, wheat and grain sorghum and forsook very largely the less succulent and tougher wild grasses. It is to-day a severe pest of these crops over most of the great plains region.

Whether a balance forcing this pest to relative obscurity, or at least to numbers comparable with other members of its family, will ever be attained is mere speculation. No other Lygaeid is so abundant or as destructive in the western hemisphere, and Imms mentions only one economic species from Egypt and one from Australia for the rest of the world.[8] Again, varieties of corn and wheat resistant to this pest may check its conquest, but, so far, it shows little disposition to yield except when forced by an open warfare of man's artificial control methods.

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[7] Reginald H. Painter, *et al.*, "Resistance of Varieties of Winter Wheat to Hessian Fly," Kans. Agri. Exp. Sta. Tech. Bul. 27, 58 pp. 1931.

[8] A. D. Imms, "A General Text-book of Entomology." Methuen and Co., London. (Ref. p. 347).

The chinch-bug has few enemies. It is true that fungous diseases may develop and destroy them in great numbers, under favorable conditions, but it probably is no more serious to the chinch-bug race than an epidemic of influenza is to man. The chinch-bug egg parasite exerts a most inadequate check[9] from man's view-point, though as many as 50 per cent. of the eggs may be destroyed by it.

Wireworms (*Melanotus* spp.) fed on roots of grasses before the great plains came under man's influence, but probably were of little consequence. The stand of these perennial grasses was thick and the root system large. They could easily spare a few roots. When the sod was plowed up and the land planted to wheat or corn, wireworms were provided with more attractive food. All the worms formerly in two or three square feet of sod concentrated on each hill of corn. The small stalks, in the spring, could not withstand their attacks. These native grass-feeding insects are to-day major pests in the eastern half of Kansas.

Other pests of corn have changed from wild food plants to this nurtured crop of man grown in large acreages. The common stalk borer (*Papaipema nebris*) may develop in as many as 176 different species of plants, most of them weeds. Even to-day weedy corn fields, or fields with weedy borders are more heavily infested with stalk borers than are clean fields. The corn earworm (*Heliothis obsoleta* Fab.), a native pest, probably maintained a precarious existence on teosinte, an ancestor of our corn, in Mexico, or in pods and fruits of some wild plants of the great plains region which, in Kansas, have been almost wholly forsaken now for the farm corn crop and alfalfa. Corn is most susceptible to attacks in the early spring when the plants are small and delicate.[10] Its enemies are chiefly the grass-feeding forms which overwinter in some advanced stage of development.

Our grasshoppers are also native, so probably have been here for many centuries. They readily forsake the tough grass for the more succulent corn and alfalfa. It required no long adaptive processes on the part of grasshoppers, since they are general feeders and corn was immediately attractive. The great swarms of Rocky Mountain grasshoppers (*Melanoplus spretus*) of 1873–75, and earlier, are now mere interesting history. It is now known that this species is but a migratory or long-winged phase of one of our most common species, the lesser migratory grasshopper (*M. atlantis mexicanus*). There was an invasion of the lesser migratory species in southwest Kansas in 1913, according to Professor George A. Dean, but it has not developed since, so far as Kansas is concerned. The grasshoppers which appeared last year (1931) were not migratory, but grew up and increased in numbers in the immediate community where they did their damage. Man is now armed with some good weapons in the warfare against grasshoppers, so farmers generally do not fear them but are able to cope with them. The frequent occurrence of outbreaks shows that they are still out of balance. When the great plains are more fully under cultivation, as occurs when the land is divided into small farms, grasshopper outbreaks will likely be a rare occurrence or be absent entirely. They continue in the great plains region as one of the few surviving biological remnants of the "wild and woolly West."

SOME NATIVE PRAIRIE FORMS WHICH ATTACK ALFALFA

From Persia to Europe, from Spain to Chile, to California, and then to Kansas came, some sixty years ago, a crop called alfalfa, lucern in Europe. It grew well, had few enemies and became a wonderful dual purpose crop. It built up the soil and furnished from three to five cuttings of good hay each year. Up to fifteen years ago it would maintain a stand on Kansas soils for ten to fifteen years. The large acreages and yields of the great plains states attest its success as an agricultural crop in this region.

The growing of alfalfa has become a difficult procedure during the last decade, and the acreage grown in Kansas has declined sharply. The average of 1930, 640,299, is a little less than half that of 1915, 1,359,498. Up to about 1905, the insect enemies were not very strong limiting agencies. Now, they so weaken the plants that disease, particularly root diseases, combined with other factors have reduced the life of the stand from ten or fifteen years to about three or four years. Several striking examples which suggest an explanation of this changing status may be mentioned.

The garden webworm (*Loxostege similalis*) had always been satisfied with weeds, chiefly pigweed (*Amaranthus*) and lamb's quarter (*Chenopodium*) but it has lately added alfalfa to its menu. In the 80's, when western Kansas was being settled, idle fields soon grew a crop of pigweed which was attacked by hordes of garden webworms. We have reason to believe that it now prefers alfalfa to weeds, since observations of the outbreaks in 1923 to 1931 have rarely shown a heavier attack on weeds than on alfalfa. If both were abundant, both were fed upon; if there were few webworms, they were largely confined to alfalfa. Its frequent outbreaks would indicate that the garden webworm is out of balance because alfalfa and other crops have unbalanced primitive nature.

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[9] J. W. McColloch, "Further Data on the Life Economy of the Chinch-Bug Egg Parasite," *Jour. Econ. Ent.*, 1915, 8: 248–260.

[10] Stephen A. Forbes, "The General Entomological Ecology of the Indian Corn Plant." *Bull. Ill. Nat. Hist. Surv.*, 18 (Art. 7), 447–457, 1929.

The pea aphid (*Illinoia pisi* Kalt.) first appeared in outbreak proportions on alfalfa in Kansas in 1921 and became at once a major pest of the crop.[11] It had formerly existed in small numbers only on garden peas and the clovers. It was instrumental in the destruction of over 100,000 acres of alfalfa in this first outbreak and it has since continued as an annual threat to this valuable crop.

The fall army worm (*Laphygma frugiperda*) has likewise found alfalfa attractive. While not fully forsaking its native wild food of grasses, particularly bent grasses and volunteer wheat during late summer, it has become an almost annual pest of this crop, at least in localities.

The corn earworm first seriously damaged alfalfa foliage in Kansas fields in the fall of 1911. This insect has always shown a decided preference for corn, certain garden crops and cotton. The silks of corn are, however, too dry in September and October to be attractive to the moths, and the kernels are too hard for the larvae. The moths then feed on the nectar of alfalfa blossoms and lay their eggs on the tender green foliage of this plant. The parasitic enemies of the larvae can find them most easily when exposed on alfalfa plants, and the percentage of parasitism is always higher than in larvae taken from ears of corn.

Pocket gophers have increased in alfalfa fields because of the fine source of food offered by the roots and because snakes and hawks, their natural checks, have been killed off; so these and many more factors, without adequate checks, are making the growing of alfalfa difficult. From the view-point of nature, the insect pests and the gophers are merely operating to restore a balance in vegetation.

SOME MISCELLANEOUS EXAMPLES OF CHANGED FOOD HABITS OR HOST RELATIONS

The Colorado potato beetle (*Leptinotarsa 10-lineata*) was content to feed upon nightshade and horse-nettle (*Solanum* spp.) until cultivation of potatoes offered new fields of conquest. This insect has almost forsaken its wild hosts for this closely related but more succulent and more easily available crop.

The potato leaf-hopper (*Empoasca fabae*) probably was an unimportant feeder on some wild grasses in the historic past, but has since found such crops as beans, peas, alfalfa, red clover and potatoes much more to its liking. It has become a serious enemy of all its hosts by causing an injury of the type known as "hopper burn" on potatoes. No group illustrates the change from a grass and weed-feeding status to an economic enemy of crops any better than do the leaf-hoppers.

Cattle appear to be more commonly attacked by enemies and diseases than was the native bison. The latter did not have to contend with tick fever, since this disease probably was introduced, supposedly by Spanish cattle. It appears that ox warbles may be native pests and not necessarily introduced from Europe, since they have been bred from buffalo[12]. However, "The American bison do not appear to be so heavily infested as are cattle raised under similar conditions in the same region."

The vegetation of the great plains also shows a succession correlated with the progress of agriculture. Plowing up the sod makes possible the growth and multiplication of some weeds which were largely crowded out in competition with the dense sod. The common wild sunflower, the Kansas state flower, soon appropriates any idle fields. Russian thistle, according to my colleague, Dr. F. C. Gates, has attained its peak of population, and better agricultural practices are now reducing the numbers of this weed. Buckthorn (*Plantago lanceolata*) introduced as a contamination of grass or alfalfa seeds, appears to be on the increase. Dandelion and field bindweed both appear to be on the increase too. Even the eastern bluegrass has a foothold in the eastern third of Kansas and, though the climate is less suited to it than that of the North Central States, often crowds out native grass when the original sod is plowed up.

Many forms are even to-day in the process of changing from wild hosts to the cultivated crops of man. It may be that they find the cultivated crops more nourishing or more tasteful. Or perhaps it is because the cultivated plants are so much more accessible, since great areas of pure cultures occur. The sunflower beetle (*Rhodobaenus 13-punctata*) has lately been found to attack beets in Kansas. Flea beetles (*Epitrix* and *Systena* spp.) are increasingly important as pests of the early garden. So apparent is the shift from native prairie vegetation that at the Kansas State College and elsewhere especial study has been and is being made of this ecological unit or complex, since so many of our chief pests are native prairie forms which find the new order of things more favorable than the old prairie conditions.[13]

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[11] Roger C. Smith and Edgar Davis, "The Pea Aphid (*Illinoia pisi* Kalt.) as an Alfalfa Pest in Kansas," *Jour. Agr. Res.*, 33: 47–57, 1926.

[12] F. C. Bishop, *et al.*, "The Cattle Grubs or Ox Warbles. . . ." *U. S. D. A. Dept. Bull.* 1369. (Ref. on p. 20), 1926.

[13] Charles C. Adams, "An Ecological Study of Prairie and Forest Invertebrates," *Bull. Ill. Lab. of Nat. Hist.*, 11: 33–280, 43 plates, Bibl., 1915; Geo. O. Hendrickson, "Studies on the Insect Fauna of Iowa Praries," *Iowa*

There is evidence that one of the chief reasons why a balance is ultimately established in nature is that resistant plants survive, while the less resistant ones succumb. Therefore, in time, a certain amount of resistance to the attacks of parasite and animal enemies characterizes the native vegetation. Cultivated crops do not show this resistance unless resistant strains are selected by man to propagate the species or unless the crop has been grown in a fairly stable environment for a long time. There is further evidence that wild plants which exhibit certain degrees of resistance to enemy attacks in nature have this resistance factor weakened by a changed environment.[14] Native prairie vegetation may be losing some of its vigor, hardiness and resistance to its enemies by the changed environment brought about by present-day conditions.

The principle of biological control is to increase the natural enemies or checks of a species by additional species of parasites, predators, or diseases, or by releasing, after artificial propagation, a large number of individuals of a common species. Some outstanding examples of biological control of noxious weeds and insects have occurred. The control of the cottony cushion scale by the Australian ladybird beetle is a well-known example among insect pests. The present-day control of prickly pear in Australia, with the cochineal scale insect and the control of the sugar cane moth borer in Hawaii, are well-known outstanding example. In these and similar instances, man has aided nature in supplying the checks to certain forms which hold them to small numbers. Eradication has never yet been attained in biological control and probably will not be accomplished. It is a graphic example, enacted dramatically in a brief space of time of a restored balance.

Man with his agriculture has upset the age-long balance of nature in the great plains region, and a new balance has not been reached. It probably is a long way off, in fact, since man is constantly changing his agriculture. Nature works slowly and not necessarily for the benefit of man. New factors under modern civilization are always being introduced which tend to postpone attainment of the new balance. Most natural checks, such as parasites, spread slowly. Man is aiding them somewhat. The native wild insectivorous birds are becoming more scarce. Their place is being taken by such forms as the English sparrow, mourning dove, grackles, crows, pigeons, robins and domestic fowls. These birds are primarily seed and fruit eaters, being only in part insectivorous, or insectivorous for part of the year. What is lost for man's welfare in one sector must be made up elsewhere by some other advances.

Insect and plant disease problems are actually increasing, both in number and severity in the great plains region. Man, the disturber, will have to employ artificial control efforts for a long time, or be seriously handicapped in his labors. This biological complex reminds us of a complicated and delicate machine in which a slight misadjustment of a part affects all the others. It is as a stone dropped into a quiet pool. The ripples travel outward on all sides and upset the grains of sand all along the shore.

VIRUSES[1]

By Dr. T. M. RIVERS

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This is an age of extremes. Very tall buildings, exceedingly large ships and unusually fast automobiles are indicative of modern trends. Moderation no longer satisfies. This desire for the superlative has taken possession of workers interested in infectious maladies, and now it is a common occurrence to hear talk about the minutest incitants of disease, namely, those that penetrate the "very finest" and "most impervious" filters. Extremely high buildings are not necessarily beautiful and profitable. Nor is the fastest mode of travel always the safest and most enjoyable. Large incitants of disease may be just as injurious to their hosts as are extremely minute ones. Yet the fact that a building is higher than all others and that certain etiological agents of disease are too small for resolution by means of a microscope lends an air of importance or mystery to the objects possessed of such unusual characteristics.

The sudden realization on the part of many workers that certain incitants of infectious disease may be very small and that types of infectious agents different from those already known may exist undoubtedly accounts for some of the present interest exhibited in viruses. These agents and the diseases caused by them are no more important now than they were formerly. Nevertheless, a concerted curiosity has served to focus attention upon them at this time. With this increased interest there have appeared in the literature many fantastic statements and unwarranted conclusions regarding the viruses. It is concerning some of these that I wish to make a few comments.

State College Jour. of Sci., 4: 49–179, 1930; J. E. Weaver, "The Environment of the Prairie," Bull. No. 5, Bot. Survey of Nebr., 50 pp., 1931.

[14] J. W. McColloch, "The Resistance of Plants to Insect injury," Bien. Rept. Kans. State Hort. Soc., 37: 196–208, 1924.

[1] Presidential address, the American Society for Clinical Investigation, Atlantic City, May 2, 1932.

Before protozoa and bacteria were known to exist, infectious diseases were thought to be caused by the wrath of the gods, miasmas, dirt and configurations of the stars. The idea that maladies might be induced by minute plants and animals seemed absurd. After much work and strife, however, it was clearly demonstrated that bacteria and protozoa do incite disease. Indeed, the fact was so firmly established that most, if not all workers, reasoning by analogy, came to believe that all infectious maladies are caused by fungi, bacteria, spirochetes, protozoa, or some form of these agents. The notion now held by some workers that primitive forms of life different from those mentioned may exist or that inanimate agents, reproducible in series, may cause infectious diseases has seemed ridiculous to many investigators. Although such ideas appear strange at first, there is no obvious reason, except analogy, to suppose that infectious diseases can be caused only by fungi, bacteria, spirochetes and protozoa, or that all infectious agents must be animate. One should not be dismayed by new ideas lest in future years one be listed with the skeptics who continued to believe the world flat in spite of proof to the contrary. On the other hand, one should not be too eager to embrace every new doctrine lest the mental tranquillity secured by the acceptance of a logical explanation—not necessarily the true one—blunt intellectual acuity.

Frequently one encounters statements that the virus diseases represent a group of infectious maladies of unknown etiology or that the virus group serves as a "catch-all" for infectious processes whose inciting agents are unknown. Such statements indicate that the etiological agents of smallpox, vaccinia, yellow fever, rabies and poliomyelitis are unknown. It is true that the exact nature of these agents is unknown, but to say that the agents themselves are unknown is somewhat of an exaggeration. Individuals who believe them to be unknown tacitly admit that they are incapable of knowing infectious agents that are invisible or unable to grow on lifeless media. Without going into a detailed philosophical discussion of what can and can not be known, one is justified in saying that the viruses of smallpox, vaccinia, yellow fever, rabies, poliomyelitis, herpes simplex, foot-and-mouth disease, fowl-pox, fowl plague, canine distemper and psittacosis are not entirely unfamiliar to the initiate. They can be separated one from another and from ordinary bacteria. Furthermore, in many instances their presence in a variety of materials can be ascertained with much more ease and assurance than is the case with certain bacteria. The old admonition regarding human beings, "Ye shall know them by their fruits," is quite applicable to the viruses, because they are known by their activities, that is, by the type of host or hosts attacked, by the clinical and pathological pictures induced, and by the immunological responses excited. In order to know an infectious agent it is not essential to see it or to grow it on laboratory media any more than it is imperative to see electricity in order to recognize it and to control it for our daily needs.

In 1873, Bollinger described in cells infected with the virus of fowl-pox large bodies that he considered the protozoan incitants of the disease. When it was demonstrated that the virus of fowl-pox is capable of passing through bacteria-tight filters, the Bollinger bodies, 7 to 25 μ in diameter, became discredited as the causal agent until Borrel and others showed that these structures consist of lipoidal capsules within which numerous minute coccoid bodies of uniform size are embedded in a protein matrix. At present certain investigators contend that the Borrel bodies are minute living organisms and represent the virus of fowl-pox. These contentions are based on the facts that the bodies are always present in infectious material, that they are uniform in size, that they have the appearance of minute organisms, and, finally, that they agglutinate in the presence of specific antisera. Such facts may be considered presumptive evidence that the Borrel bodies are minute organisms, but they are not conclusive, because as yet one can not by morphological and tinctorial data alone determine whether autonomous life exists in them. Furthermore, one dare not state that agglutination of particulate matter by a specific serum is proof of autonomous existence in such agglutinable particles, because it has been demonstrated that collodion particles treated with a variety of proteins and then thoroughly washed are specifically agglutinated by the proper antisera.

For a long time a few investigators have held that certain virus diseases are induced by ordinary bacteria. Now that attention is being focused on filterable forms of bacteria, workers in increasing number are adopting the belief that viruses are merely filterable, invisible and noncultivable elements of ordinary bacteria. Without going into details of the available knowledge of bacterial life cycles and their invisible and noncultivable forms, one can say that proof of many of the claims regarding them is lacking. Since even the existence of bacterial life cycles is doubtful, it seems unwarrantable to offer presumptive filterable forms of them as the explanation of another unsolved problem, the nature of the viruses.

Numerous workers seem to be convinced that the viruses are animate organisms, probably extremely minute bacteria. Yet they do not hesitate to state that the diameter of the etiological agent of foot-

and-mouth disease is 8 to 12 μμ. If such figures are accurate, then this virus is indeed very small, not much larger than a molecule of hemoglobin which is now believed to be approximately 5.5 μμ in diameter. Is it possible for an aggregate of so few protein molecules to be an organized living creature possessed of metabolic and reproductive powers comparable with those of minute bacteria? I am glad that I am not constrained to answer this question. Nevertheless, those who insist, without more evidence than is now at hand, upon the living nature or at all events upon the bacterial nature of the virus of foot-and-mouth disease, should at least manifest some appreciation of the difficulties of believing this.

As a rule viruses are smaller than ordinary bacteria. There is no reason to suppose, however, that all of them are of an identical order of magnitude any more than it is necessary to assume that all bacteria or all animals are of one size. Nor is there sufficient evidence to justify the belief that all viruses are of the same nature. Some may be inanimate transmissible incitants of disease, others may be primitive forms of life unfamiliar to us, still others may be minute living organisms. If it be assumed that the viruses differ in natures, one comes up against the question of why the diseases caused by them manifest many striking features in common. To find the answer to such a question may not be exceedingly difficult. At least a partial solution might well lie in the phenomenon of the intimate association of the viruses, animate or inanimate, with the susceptible host cells. Furthermore, the viruses may be situated near the line that separates inanimate transmissible incitants from minute living organisms. The transition from one side of the line to the other may be so gradual that no great difference in the types of disease caused by agents near the line is perceptible. Such a statement is strongly reminiscent of a remark by Aristotle that "nature makes so gradual a transition from the inanimate to the animate kingdom that the boundary lines which separate them are indistinct and doubtful."

To the naturalist it is undoubtedly of importance to know whether the viruses are living autonomous agents or products of cellular perversion capable of inciting similar perversions in other cells. Would a definite solution of this problem lead forthwith to great advances in the handling of virus diseases? At the moment I see no reason to suppose that it would. What, indeed, would be gained in this direction, were it possible to see, to define the nature of and to cultivate in abundance on ordinary media the etiological agents of poliomyelitis, smallpox, yellow fever, measles and varicella? Certainly nothing of a startling nature. Practical problems would for a while at least remain much as they are now, because already the viruses of smallpox, vaccinia, poliomyelitis, yellow fever and many other diseases can be handled, identified and kept free from bacteria. Moreover, many of these maladies can be experimentally induced in animals and highly protective and neutralizing sera can be obtained. Furthermore, there are successful methods of vaccination against many virus infections, notably smallpox, rabies, yellow fever, fowl-pox, canine distemper and cattle plague. I have little patience with those who state that just as soon as the viruses are cultivated on lifeless media, it will be possible to make vaccines to prevent and sera to cure the diseases caused by them. Had we waited for the cultivation of the viruses, we would still be without Jennerian prophylaxis and antirabic vaccination. Indeed, Jennerian prophylaxis was firmly established before it was known that bacteria cause disease. Furthermore, it is exceedingly doubtful whether viruses cultivated on ordinary media would lead to the production of antiviral sera superior to the ones already obtainable, for example, those against smallpox, measles, yellow fever, foot-and-mouth disease and poliomyelitis, the value of which as curative measures is questioned by many investigators.

Numerous diseases spread by means of water, milk, food, filth and insect vectors have been controlled not by preventive vaccines and curative sera, but largely through the improvement of sanitary conditions. Many viruses obtain entrance into their hosts by way of the upper respiratory tract. Our inability to control disorders arising in this manner is not due to the fact that we have not used some special kind of medium for the cultivation of the viruses, but because it is essential that we breathe, and as yet no one has suggested a practical method of obtaining uninfected air for human beings living amongst their fellows.

For more than thirty years investigators in considerable number have waited for the veil of mystery that surrounds the viruses to be lifted by deft hands capable of cultivating these agents on lifeless media. If the viruses are minute obligate parasites incapable of multiplication in the absence of living susceptible host cells, or if they are products of cellular perversion reproducible in series, then to wait for this to eventuate is a waste of time. Fortunately a number of workers are already attempting by other means the study of the virus diseases and their etiological agents. That a certain amount of success may attend these methods is proven by the results of recent work on vaccinia, psittacosis, canine distemper, poliomyelitis and yellow fever.

OBITUARY

THOMAS H. GRONWALL

Through the death, on May 9, of Dr. Thomas H. Gronwall, of Columbia University, America has lost one of its outstanding mathematicians.

Dr. Gronwall was born at Axberg, Sweden, on January 16, 1877. He received his Ph.D. from Upsala in 1898. He then went to Berlin, where, until 1902, he studied engineering. Soon after taking his engineering degree, he came to this country. Here he held various technical positions and also filled academic posts at Princeton and at Columbia.

Gronwall's work covered a wide variety of subjects. He wrote on analytic functions, infinite series, nomography, the analytic theory of numbers, differential geometry, integral equations, ballistics, elasticity, electrical theory and relativity. Some years ago he was associated with Professor V. K. La Mer in a revision of the Debye-Hueckel theory.

In pure mathematics, Gronwall's best known papers are probably those on analytic functions of several variables and on the summability of Laplace series. In his dissertation, he extended the Weierstrass factorization theorem to functions of several variables. In later work, he did much to clear up the problem of the representation of a meromorphic function of several variables as a quotient of two analytic functions. He developed for Laplace series a summability theory analogous to that of Fejer for Fourier series.

Gronwall's knowledge was encyclopedic. He was a prodigious reader, quick in assimilating ideas and retentive in memory. He possessed analytic skill of a high order and great elegance of style.

While Gronwall was of a reserved nature, those who knew him intimately appreciated the depth of his culture and his wealth of intellectual interests. In his premature death, we have lost a great savant and a brilliant personality.

J. F. Ritt

Columbia University

ELLEN CHURCHILL SEMPLE—1863–1932

Dean of American geographers, noted author, and one of the world's foremost educators, Miss Semple achieved a life marked by untiring devotion to duty. Louisville, Kentucky, was her birthplace in 1863, her parents being from two of the old families of the Blue Grass. In 1882, at nineteen, she became a bachelor of arts from Vassar College. Graduate work in history combined with extensive travels in Europe prepared her to take a master of arts degree at Vassar in 1891. Once more in Europe, she gave herself to work in anthropogeography under Ratzel, whose influence changed her interest from history to geography. "American History and Its Geographic Conditions," published in 1913, was forerunner to a number of scholarly treatises including "Influences of Geographic Environment" and "The Geography of the Mediterranean Region."

Miss Semple was a truly great teacher. She set high standards, not only for us, but also for her successors. Although she was never trained specifically for the teaching profession, so outstanding were her accomplishments in the field of anthropogeography that she was called in succession to several European and American universities to lecture on geography.

Catholicity of interest and ability to select and apply facts and principles from an inexhaustible fund of knowledge lifted her lectures above the plane of ordinary instruction. She demonstrated to a marked degree how "nature and books belong to the eyes that see them." Her capacity for observation was enormous. Since her keen curiosity ever prompted her to seek and inquire, she derived the maximum benefit from her studies in the field. She knew "how wide was the far horizon of geography." Because of these qualities she vitalized her teaching by personal observations and incidents selected from her rich and varied experience. She told stories with true dramatic effect and with flashes of wit that enlivened her discussion and made it a real and dynamic exposition.

In 1914 she was awarded the gold medal of the American Geographic Society and in 1932 the gold medal of the Chicago Geographical Society. Upon establishing the Clark School of Geography, I called Miss Semple to be the first geographer of the new staff. Although she ceased university teaching two years ago, she continued on the faculty roll. As lecturer, writer and guide to students, Miss Semple had few her equal. She was a woman of exquisite personal charm and thorough scientific integrity. She exerted a compelling influence over all her friends and associates.

Wallace W. Atwood

MEMORIAL TO DR. JOHN BRIQUET

Dr. John Briquet, late director of the Botanical Garden, Geneva, Switzerland, died on October 26, 1931, at the age of sixty-one years, after a brief illness. Those botanists who attended the International Botanical Congresses in 1900, 1905, 1910, 1926 and 1930 will realize the great loss botany has suffered by his death. As stated in a recent appeal issued by a committee of distinguished Swiss botanists, Dr. Briquet was an outstanding figure in all discussions on nomenclature, and the rôle he played as recorder, by his tactful, sagacious and conciliatory nature, together with his great knowledge of languages and absolute command of the matter in hand, left an indelible impression on the minds of all. Thus he contributed greatly to the unifying of botanical nomenclature, and his services at the memorable congress held at Cambridge, England, in 1930 will long be gratefully remembered.

The Committee of Swiss botanists consisting of Messrs. Christ, Hochreutiner, Oechslin, Rübel, Schinz, Schröter and Wilczek, plan to provide a bronze bust of Dr. Briquet to be placed in the Conservatoire botanique in Geneva, along with those of Vaucher, De Candolle, Boissier, Ascherson, Engler and others who very materially advanced the interests of the institution to which Dr. Briquet himself contributed in so large a degree. It is estimated that approximately $1,000 will be needed for this most worthy memorial. The committee fully realizes the difficulty it faces in raising the necessary amount at this time, and expresses the hope that American botanists will generally subscribe to the project, in order that the task of establishing the memorial may be consummated without delay. Subscriptions may be sent to M. le Prof. Wilczek, Palais de Rumine, Musée botanique, Lausanne, Switzerland.

E. D. MERRILL

NEW YORK BOTANICAL GARDEN

SCIENTIFIC EVENTS

BIRTH RATES AND DEATH RATES

THE Metropolitan Life Insurance Company has made public the following facts in regard to the decline of the birth rate:

In twenty-four out of forty-two of the world's large cities the birth rate declined more than 5 per cent. in 1931 as compared with 1930.

The ten large German cities all showed declines of more than 10 per cent. in live births in 1931 over 1930. In Berlin the birth rate last year reached the low figure of 8.7 per 1,000, the lowest figure for any of the German cities having a population of 500,000 and over and one of the lowest birth rates for any city in the world. The 1931 birth rate in Berlin was the lowest in the history of that city and may be compared with the rates of 11.2, 17.5 and 11.4 per 1,000 prevailing in Berlin in 1925, 1920 and 1915, respectively. In Dresden and Frankfort the birth rate fell below 10 per 1,000 for the first time in the peace-time history of these two cities.

Every one of the fourteen large American cities recorded a drop in the birth rate during 1931. The decline was 22 per cent. in Boston and 17 per cent. in Detroit. The only large city in the United States with a birth rate over 20 per 1,000 was Pittsburgh, and there the rate declined more than 6 per cent. from the 1930 figure.

A favorable record was registered for mortality during 1931 in these world cities. All the German cities had either a substantially lower death rate in 1931 than in 1930 or else a stationary death rate. In Breslau and Frankfort the decline in mortality during 1931 was greater than 10 per cent. Munich, Leipzig and Dresden had declines of between 5 and 10 per cent. The Berlin death rate was unchanged.

Among fourteen of our American cities slight increases in the death rate were observed for five cities and decreases for six, with Detroit and Milwaukee leading in the latter classification. How much of the decline in mortality, as well as in the number of births, in Detroit was due to the emigration of persons by reason of the prevailing unemployment conditions is not known. The death rate in New York City showed a very small increase, less than 1 per cent. during 1931.

World economic conditions during 1931 affected chiefly the birth rate, and this may be a side effect of prevailing world conditions upon the marriage rate. The extent to which declining marriages in 1930 and 1931 affected first births, the crude birth rates and infant mortality rates in 1931 can not as yet be determined from the figures at hand. Death rates and infant mortality rates have not shown as yet any definite effect of the economic situation.

INVESTIGATION OF THE WOODS OF THE WORLD

A SYSTEMATIC investigation of the woods of the entire world by the International Association of Wood Anatomists is now well advanced, according to a statement made public by the secretary-treasurer, Professor Samuel J. Record, of the Yale School of Forestry, who recently announced the results of a conference, held in New Haven, of representatives of the Bussey Institution and the biological laboratories of Harvard University, the botanical department of Cornell University, and the forestry department of Yale. The organization has a membership of fifty investigators in eighteen different countries under the direction of an executive council of eleven members of eight nationalities.

The largest and most comprehensive collection of woods in existence at present is at the Yale School of Forestry. It contains over 21,000 fully catalogued samples representing over 6,000 named species of about 2,000 different genera. Cuttings large enough for scientific studies have been made of selected groups and forwarded to workers in several institutions in the United States, Canada, England, Holland, Germany, France, Russia, Japan, Australia and New Zealand. Another large collection is at Buitenzorg, Java, with 15,000 samples of Dutch East Indian woods. There are also large collections in the Philippines, India, Federated Malay States, as well as in European countries, and hundreds of samples have already been distributed for special research.

The Yale Forestry School is trying the experiment of providing small subventions for local collectors in tropical countries and is said to be meeting with marked success. Over 300 timber samples have recently been received as the result of a local expedition into the high mountain range near Santa Marta, Colombia. The Lower Amazon region is being explored by Dr. Alphonso Ducke, of the Botanical Garden of Rio de Janeiro. Dr. A. Rimbach is collecting in the interior of Ecuador, a locality almost unknown to the outside world. A good collection of woods has been made for the first time on Mt. Kinabalu in British North Borneo. The most recent expedition is that of Mr. J. H. L. Waterhouse, of Australia, who is collecting on the British Solomon Islands Protectorate. This undertaking is in cooperation with the Royal Botanic Gardens, Kew, England, and has the sanction of the high commissioner for the Western Pacific and the resident commissioner at Tulagi. There are, in addition, many local collectors in out-of-the-way places in the tropics.

The first step toward uniformity of botanical terms has been the making of a dictionary, now undergoing its second revision, which is in English, French, German, Dutch, Spanish, Portuguese and Polish. This will be made the basis for a book in which every term will be fully illustrated and described.

GOVERNMENT CONTROLLED FOREST LANDS

THE merging in one department of all federal agencies and auxiliary services administering government owned or controlled forest lands has been recommended by an advisory subcommittee of the U. S. Timber Conservation Board headed by Dr. Henry S. Graves, dean of the School of Forestry of Yale University. According to a statement issued by the board, the principal recommendations are:

Merging in one undesignated department the several administrations of federally-owned or controlled forest lands, together with all auxiliary services pertaining thereto.

The abolishment of the present system of paying to counties a percentage of the National Forest receipts, substituting therefor direct contribution to be adjusted, in a degree, to local needs. This is to be paid annually and such procedures should possibly be helpful in improving state forest taxation methods.

Extreme conservatism in public timber disposal, apparently recognizing the principle that publicly owned timber is a reserve supply to be drawn on only as required to advance public interest, local and national.

Steps to harmonize federal forest acquisition and administration and to promote sound controls thereunder.

Cooperative study by government and states of problems of tax delinquency in critical regions where forestry protection is threatened. This may suggest either public acquisition or the use of public timber supply to extend the operations of private concerns toward the continuance of local community interests.

THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

THE annual meeting of the American Society of Agricultural Engineers was held at Ohio State University from June 20 to 23. A symposium on "An Engineer's Policy for Agriculture" was a feature of the meeting. The president of the society, Leonard J. Fletcher, of Peoria, Illinois, general supervisor of agricultural sales of the Caterpillar Tractor Company, presided. The speakers were C. F. Kettering, of Detroit, president of the General Motors Research Corporation; J. T. Jardine, chief of the Office of Experiment Stations, U. S. Department of Agriculture, and Arthur Huntington, public relations engineer of the Iowa Railway and Light Corporation. Several hundred engineers, economists, farm leaders and scientific men from universities, technical schools, the industries and state and federal services participated.

The convention opened with sessions of the college division. Among the speakers were R. J. Baldwin and George Amundson of Michigan State College; Ben D. Moses, of the California Agricultural Experiment Station, and R. W. Trullinger, of the U. S. Department of Agriculture. The topics discussed included cooperative relations with industries, agricultural engineering teaching, agricultural engineering research, agricultural engineering extension, relations with vocational education, and logical future development of research in agricultural engineering.

Dr. George W. Rightmire, president of the university, addressed the delegates on Tuesday morning and Mr. Fletcher delivered the annual presidential address. Other addresses included "Adventures in Science" by Dr. L. A. Hawkins, of the Research Laboratories of the General Electric Company; "Fuels for High-Compression Motors," by Thomas Midgley, Jr., a director of the American Chemical Society; "An Agricultural

Engineer's Observations in Russia," by E. J. Stirniman, formerly associate professor of agricultural engineering at the University of California and later agricultural engineer for the Grain Trust of the Soviets, and "To-morrow's Job for the Agricultural Engineer," by President Fletcher.

At a general session on Thursday morning L. A. Jones, chief of the division of drainage and erosion control, Bureau of Agricultural Engineering, U. S. Department of Agriculture, discussed "Soil Erosion—A National Menace"; M. S. Winder, secretary of the American Farm Bureau Federation, spoke on "How the Farmer Looks at the Engineer," and Professor F. W. Duffee, of the University of Wisconsin, described "A Specific Example of a Planned Engineered Agriculture."

Other speakers at the Columbus meeting were: Professor Moses; W. B. Robert, Aluminum Company of America; M. A. R. Kelley and S. P. Lyle, U. S. Department of Agriculture; H. B. White, University of Minnesota; J. L. Strahan, consulting agricultural engineer; Professor F. L. Fairbanks and Professor H. W. Riley, Cornell University; F. P. Hanson, Caterpillar Tractor Company; Professor L. D. Baver, University of Missouri; Roy Bainer and J. P. Fairbank, University of California.

THE INTERNATIONAL CANCER RESEARCH FOUNDATION

MR. WILLIAM H. DONNER, of Villanova, Pa., retired steel manufacturer of Pittsburgh, has placed at the disposal of this foundation cash and securities on the basis of to-day's values amounting to $2,000,000. This was set aside by Mr. Donner as a trust in 1929 when his son, Joseph W. Donner, died in Buffalo.

The object of the foundation, as announced by Mr. Donner, is to "increase interest in and the amount and quality of cancer research; develop new minds and theories; broaden the viewpoint of some investigators already in the field, and increase cooperation among scientists throughout the world, correlating results of their investigations and preventing duplication of work."

No money will be given for buildings, and the funds will not be spent in any one institution, state or country. Not more than 35 per cent. of its income is to be allotted to one institution, not less than 50 and not more than 65 per cent. within the United States.

At the organization meeting on June 8, the following officers were elected:

President: W. H. Donner.
Vice-President: A. V. Morton.
Treasurer: The Fidelity-Philadelphia Trust Company.
Secretary: Dr. M. W. S. Schramm.

The directors include, in addition to the president and vice-president: Dr. Thomas S. Gates, president of the University of Pennsylvania; The Honorable George Wharton Pepper, former United States Senator; Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, of Pittsburgh.

Drs. James Ewing, of New York City; Burton T. Simpson, of Buffalo, and Francis Carter Wood, of New York City, constitute the scientific advisory committee.

RETIRING MEMBERS OF THE FACULTY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE retirement of four members of the faculty of the Massachusetts Institute of Technology after more than forty years of service, has been announced. These are Frank A. Laws, professor of electrical measurements; James R. Lambirth, assistant professor of mechanical engineering; Robert H. Smith, professor of machine construction, and Arthur G. Robbins, professor of topographical engineering. They all retire with the title of professor emeritus.

Professor Lambirth has had the longest service. He has been instructing in forging for 48 years, and nearly 15,000 students have passed through his class. At the age of eighty-four years he is still active. He is a native of Chelmsford, England. Professor Lambirth joined the staff of the institute in 1884. Until several years ago he had not known illness, and for thirty-nine years he never missed a class.

Professor Laws, who is a native of Brockton, is a graduate of the class of 1889. He joined the staff in the year of his graduation as an assistant in physics, and in 1897 became assistant professor of electrical measurements. From 1906 until 1913 he held an associate professorship in electrical testing. Professor Laws was a member of the staff of the research laboratory of electrical engineering in 1913–14, and a member of the research division of the department since 1918.

Professor Smith's teaching career at the institute began in 1886. In 1919 he was appointed assistant professor of mechanical engineering, and was promoted to the rank of professor of machine construction in 1931. Professor Smith is well known to generations of Technology students. He is the author of "Elements of Machine Work," "Principles of Machine Work," and "Advanced Machine Work." In April, 1928, he was elected an honorary member of the Technology Alumni Association.

Professor Robbins in 1886, the year of his graduation, joined the staff as assistant in civil engineering. He was appointed assistant professor of highway engineering in 1896, and in 1906 became associate professor of topographical engineering. He was promoted to the grade of professor three years later. For many years he was a member of the teaching staff at Technology's summer school of civil engineering at East Machias, Maine. He is a member of the Boston Society of Civil Engineers and affiliated with the American Society of Civil Engineers.

To each of these retiring members President Compton has written an expression of the gratitude of the institute for their long and important service to the institute.

SCIENTIFIC NOTES AND NEWS

Dr. Graham Lusk, professor of physiology emeritus at the Cornell University Medical College, has been elected a foreign member of the Royal Society, London.

At a dinner of the Advisory Board of the Wistar Institute of Anatomy on May 29 Dr. George E. Coghill, managing editor of *The Journal of Comparative Neurology*, announced the dedication of a complimentary volume of the journal to Dr. Henry H. Donaldson in celebration of his seventy-fifth birthday and in recognition of his many years of service to the science of neurology.

There will be held a meeting of appreciation and a tribute to Frank J. Sprague, the distinguished electrical engineer, on July 25, the seventy-fifth anniversary of his birth. The meeting will be held in the Engineering Societies auditorium at 8 o'clock, and addresses will be made as follows: "An Engineer's Contribution to the World's Welfare," Dr. John H. Finley; "An Engineer's Contribution to Transportation," Mr. Frank Hedley; "Frank J. Sprague—A Tribute," Rear Admiral S. S. Robison, U. S. N. (ret.); "Respone" by Mr. Sprague.

Yale University has conferred the doctorate of science on Dr. Frank R. Lillie, professor of embryology in the University of Chicago, and the doctorate of letters on Lieutenant Colonel Fielding H. Garrison, librarian of the Institute of the History of Medicine at the Johns Hopkins University.

Dr. Harvey Cushing, who retired this year from the Moseley professorship of surgery at the Harvard Medical School, received at commencement the degree of doctor of science from Northwestern University.

Among the honorary degrees conferred at commencement by Boston University was the degree of doctor of science on Dr. Frank B. Mallory, professor of pathology at the Harvard Medical School, and on Dr. William P. Graves, surgeon-in-chief at the Free Hospital for Women, Brookline.

Honorary degrees were conferred on June 13 by the Ohio State University on Charles F. Marvin, chief of the United States Weather Bureau, and on Walter C. O'Kane, professor of economic entomology at the University of New Hampshire.

The doctorate of science was conferred at the recent commencement of Colgate University on Dr. Strashimir Alburtus Petroff, director of the Trudeau Sanitarium laboratory, Saranac Lake, New York; on Dr. Homer Levi Dodge, professor of physics and director of the graduate school at the University of Oklahoma, and on Dr. Ross Vernet Patterson, dean of Jefferson Medical College, Philadelphia.

At the commencement exercises of Washington and Jefferson College on June 4, the honorary degree of doctor of science was conferred on Dr. D. J. McAdam, Jr., metallurgist of the U. S. Bureau of Standards.

At the recent meeting of the Royal Society of Canada, the Sir Joseph Flavelle medal for science was presented to Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory at Victoria, British Columbia.

A portrait of Lord Rutherford, painted by Mr. Oswald Birley, was presented to the Royal Society on June 9.

A portrait of Dr. George F. Kay, dean of the College of Liberal Arts of the University of Iowa, was unveiled at the commencement dinner on June 2, and presented to the university as a gift of the graduating classes. The portrait was painted by the late Professor Charles A. Cumming, who for many years was head of the department of graphic and plastic arts in the university.

A portrait of Dr. J. McKeen Cattell has been presented to him by colleagues and former students. The painting is by Leopold Seyffert, N.A. The committee in charge consisted of Professor A. T. Poffenberger, of Columbia University; Professor S. I. Franz, of the University of California at Los Angeles, and Dr. F. P. Keppel, of the Carnegie Corporation.

Professor George H. Shull, of Princeton University, has been elected a corresponding member of the German Botanical Society on the occasion of the fiftieth anniversary of its founding. Americans already on the list are R. A. Harper, A. S. Hitchcock, E. D. Merrill, B. L. Robinson and William Trelease.

Dr. Willard Berry, of the department of geology of the Ohio State University, has been elected a corresponding fellow of the Geological Society of Peru.

The Academy of Natural Sciences of Philadelphia has elected as correspondents the following: Liberty H. Bailey, Henry B. Bigelow, Reginald A. Daly, Ludwig Diels, John Stanley Gardiner, Hugo Glück, William D. Gregory, A. S. Hitchcock, Adolfo Lutz, Emmanuel de Margerie, Elmer D. Merrill, Edward W. Nelson, Albert C. Seward, Edgar O. Ulrich and B. P. Uvarov.

In recognition of her flight across the Atlantic, the special gold medal of the National Geographic Society was presented to Mrs. Amelia Earhart Putnam by President Hoover in special exercises on June 21. After the presentation Mrs. Putnam related to members of the society the story of her flight.

A dinner was given to Dr. Walter R. Parker by his friends and colleagues on May 24, on the occasion of his retirement on July 1 as professor of ophthalmology in the University of Michigan Medical School. Dr. Frederick G. Novy presided as toastmaster at the dinner, and Dr. Alexander G. Ruthven, president of the university, made the opening remarks.

Dr. Esmond R. Long, who recently resigned as professor of pathology in the Graduate School of Medicine of the University of Chicago, to go to the Phipps Institute of the University of Pennsylvania as director of laboratories, was awarded the Trudeau Medal by the National Tuberculosis Association at its annual meeting in Colorado Springs, Colorado, on June 6. The medal is awarded each year "for outstanding service to the tuberculosis movement."

Dr. Henry James Spencer has been appointed director of the second medical (Cornell) division of Bellevue Hospital, to succeed Dr. Eugene F. DuBois. Dr. Spencer has also been appointed assistant professor of clinical medicine in the Cornell University Medical College.

Dr. L. P. Smith, who has been spending the past year in Munich and Utrecht as National Research Fellow, has been appointed assistant professor of physics at Cornell University.

Dr. K. H. Goode, assistant professor of chemistry at Colgate University, has resigned. Dr. Sidney J. French, department head of chemistry at Franklin College, has been appointed assistant professor of chemistry, and Dr. D. W. Trainer, Jr., has been promoted from instructor to assistant professor.

At the Long Island College of Medicine, Brooklyn, N. Y., Dr. Alfred C. Beck has been appointed professor of obstetrics and gynecology, to succeed the late Dr. John O. Polak. Dr. Edgar D. Congdon has been appointed professor of anatomy. For the past five years he has been in charge of the department of anatomy at the Medical School of Chulalankarana University, Bangkok, Siam. There has been created within the department of medicine a division of preventive medicine and community health. This has been placed in the hands of Dr. Alfred E. Shipley.

We learn from *Nature* that at the annual general meeting of the Institute of Physics held on May 24, the following were elected to take office on October 1 next: *President,* Lord Rutherford; *Honorary Treasurer,* Major C. E. S. Phillips; *Honorary Secretary,* Professor A. O. Rankine. The other vacancies on the board were filled by the election of Professor H. S. Allen and Dr. C. V. Drysdale as vice-presidents, and Mr. R. A. Watson Watt and Mr. D. Orson Wood as non-official members. Sir Frank Dyson and Sir William Bragg were elected honorary fellows of the institute.

Alfred P. Sloan, Jr., president of the General Motors Corporation, and Dr. Harlow Shapley, director of the Astronomical Observatory at Harvard University, have been elected life members of the corporation of Massachusetts Institute of Technology. Martin H. Eisenhart, vice-president and general manager of the Bausch and Lomb Optical Company, Rochester, New York; Bradley Dewey, president of the Dewey and Almy Chemical Company, Cambridge, and Jerome C. Hunsaker, vice-president of the Goodyear-Zeppelin Corporation, have been elected by the alumni association term members of the corporation to serve for five years.

There were elected at the annual meeting on April 23 of the Division of Geology and Geography of the National Research Council, officers, members and executive committee for the year 1932–1933, as follows: *Chairman,* W. H. Twenhofel; *Vice-chairman,* O. E. Baker; E. C. Case, representative of the Geological Society of America; August F. Foerste, representative of the Paleontological Society; Nevin M. Fenneman, representative of the Association of American Geographers; Mark Jefferson and Morris M. Leighton, members at large; *Executive Committee,* W. H. Twenhofel, O. E. Baker, Edson S. Bastin, W. L. G. Joerg, Sidney Powers and Clarence S. Ross.

A grant has been made by the Committee on Scientific Research of the American Medical Association to the department of anatomy of the Vanderbilt Medical School for research on the effects of certain colloidal solutions on experimental syphilis.

Professor Picard, accompanied by Professor Max Cosyns, of the Queen Elizabeth Scientific Foundation, will make his second ascent for the scientific exploration of the stratosphere about the end of June or the beginning of July. The ascent, which will be made from Zurich, will have for its principal object the study of the cosmic radiation. The balloon with which the first ascent was made will be used, but a new *nacelle* will be constructed.

Professor Carl L. A. Schmidt, chairman of the department of biochemistry at the University of California, sailed last week from New York for a trip to Germany under the auspices of the Oberlaender Trust of Philadelphia. He plans to investigate methods of organization and the teaching of biochemistry in Germany, and to compare them with American methods.

Dr. C. F. Noll, professor of experimental agronomy and farm superintendent at the Pennsylvania State College, left on June 17 on a three-months tour of agricultural experiment stations. He will follow a central route westward to California, proceed north through the Pacific Coast States, and return through the northern states.

Dr. Edwin C. Voorhies, associate professor of agricultural economics in the College of Agriculture, University of California, is in New York City to study marketing outlets in the East for honey produced in California.

The Osler Oration before the Canadian Medical Association was delivered on June 24 by Dr. Francis R. Packard, editor of the *Annals of Medical History*.

Professor W. A. Bone, professor of chemical technology in the Imperial College of Science, delivered the Bakerian Lecture before the Royal Society on June 9, taking as his subject "The Combustion of Hydrocarbons."

Professor Sir Aldo Castellani, senator of Italy, delivered an inaugural address in connection with the opening of the new Clinica delle malattie tropicali of the University of Rome, speaking on "Tropical Medicine from Ancient Times down to the Present."

By the will of the late Mrs. Frances R. Biggs, widow of the late Dr. Hermann M. Biggs, New York University receives $100,000 to increase the funds for the Hermann Michael Biggs professorship of preventive medicine. $35,000 is left to the Henry Street Settlement for the Hermann and Frances Biggs tuberculosis visiting nurse fund and $1,000 to the New York Tuberculosis and Health Association. A portrait of Dr. Biggs was presented to the New York Academy of Medicine.

The American Philosophical Society and the Geological Society of America will receive $4,000,000 each from the estate of Dr. Richard A. F. Penrose, final adjudication of which was made on June 15. Dr. Penrose, the distinguished economic geologist, died a year ago, leaving an estate valued at $10,040,142. Bequests included $50,000 to the University of Chicago and $25,000 to the Economic Geology Publishing Company.

By the will of the late Dr. W. W. Keen, Brown University, of which he was a graduate and trustee, was originally bequeathed a trust fund of $100,000, but a codicil lowered the bequest to $15,000, in view of the shrinkage of values.

The *Journal* of the American Medical Association reports that with the announcement of a grant of $1,232,652 from the Rockefeller Foundation to McGill University, for the establishment of a neurologic institute, plans for the development of a neurologic center at the school were outlined. The grant will provide for the construction of a new building, especially equipped for research in neurology, neurosurgery and the physiology and pathology of the nervous system. More than $150,000 has been pledged by friends of the university and members of the governing board. Dr. Wilder G. Penfield, professor and head of the department of neurology at McGill, has been selected to direct the institute. Dr. Penfield was born in Spokane, Washington; he is a Rhodes scholar and a graduate of the Johns Hopkins University School of Medicine. His associates will include Drs. Colin K. Russel and Frederick H. MacKay, clinical professors of neurology, and William V. Cone, assistant professor of neurologic surgery, also a native of the United States. The new building will be erected on a site opposite the present neurologic laboratories in the Royal Victoria Hospital building. The institute will be connected with the hospital and the pathologic building by an underground tunnel. Tentative arrangements provide for the erection of a seven story building to contain wards for public, semiprivate and private rooms, operating rooms, research laboratories, offices and a few rooms for resident graduate students.

The China Foundation with headquarters at Peiping has awarded forty-three fellowships to Chinese scientific men for the carrying forward of research work in the fields of mathematics, physics, chemistry, botany, zoology and geology. About half the fellowships are for the prosecution of work in China, carried on by research workers who have received their training abroad, or by research fellows connected with the more prominent research laboratories. This is in contrast to the situation five years ago when the fellowships of this foundation were first awarded. At that time very little research work was being undertaken in China, and most of the awards were for the purpose of enabling candidates to secure specialized training in Europe and America. The China Foundation was established in 1925 on funds of the remitted American-Boxer Indemnity. The director is H. C. Zen, of Peiping.

The Sigma Xi Club of Peking was organized on May 20 by a group of about forty Sigma Xi alumni resident in that city. At Peking are located six large universities, a large medical school, the Geological Survey, and other research institutions. There is evidence that Peking is growing in importance as a center of scientific research. The membership of the newly formed club, of whom three fourths are Chinese, and one fourth Americans, is connected for the most part with Tsinghua University (the American Boxer indemnity school), Yenching University (a Chinese-American private institution), and the Peking Union Medical College (Rockefeller Foundation). Officers elected for the coming year are: *President,* W. H. Adolph (Pennsylvania), professor of biochemistry at Yenching University; *Vice-president,* Y. C. Mei (Worcester), president of Tsinghua University; *Secretary-Treasurer,* A. P. T. Sah (Worcester), professor of physics at Tsinghua University.

ACCORDING to a note in *Nature,* at the annual meeting of the British Science Guild held on May 25, Sir Samuel Hoare was reelected president for the ensuing year, and affirmed his faith in the aims of the Guild. The annual report shows a year of useful work. It is said that perhaps its most interesting feature is the attempt which the guild is making, in conjunction with the Association of Scientific Workers, to provide an adequate channel for bringing before Parliament the views of scientific men. A Science Advisory Council is being set up, and it is intended that this council shall be in some sense comparable with the Federation of British Industries, in the sense that it shall be the liaison body for providing contact with Parliament in connection with scientific and technical matters coming before the House. The success of the projected council will depend on the degree in which it enjoys the cooperation of scientific and technical societies, a number of which have already agreed to participate. The extent of its activities, however, will be mainly determined by that of the funds placed at its disposal, and in this aspect the matter has yet to be put on a satisfactory basis.

DISCUSSION

AN EXPERIMENT IN TEACHING PUBLIC HEALTH ZOOLOGY AT ROLLINS COLLEGE

IN 1892, I gave before the medical school of Georgetown University a course in medical zoology—the first of its kind in this country, so far as I have learned. Similar courses have since been introduced by a number of American medical and premedical colleges.

Very frequently the thought has occurred to me that a modification of courses on medical zoology, taking in the broader aspects of public health zoology, would present to students (besides those preparing for a medical career) an instructive and interesting study. An opportunity to try out the experiment was recently presented during my winter residence at Winter Park, Florida, after retiring from government service. President Hamilton Holt, of Rollins College, is always on the lookout for professional men retiring to Winter Park to live a life of ease and whom he can impress into special service in connection with the instruction at Rollins. Hearing that I had chosen Winter Park as locality in which to enjoy a few months as a member of the "Order of the Sons of Rest," he invited me to become a member of the winter faculty for 1932. The temptation to try out my idea of public health zoology at Rollins (which is proverbially ready to try out new ideas) induced me to accept the invitation—in spite of my conviction that the way for a man to "retire" is for him actually to retire. Probably my active colleagues in zoology will be interested in learning the results of the experiment.

Nineteen students who elected the course are preparing as follows: pre-medical 3, psychology 3, economics 3, teachers 2, mathematics 1, diplomacy 1, finance 1, business 1, welfare work 1, matrimony 2, book critic 1. They represented postgraduates, seniors, juniors, sophomores and freshmen. Eight were men, eleven were women. Taken all in all, this was the most enthusiastic and most progressive class to which I have given instruction—during forty years of special lecture work in various universities. Instruction lasted ten hours per week through the winter term. Within a week the class was "standing on tiptoes" and the students were asking for special assignments of work. Part of the instruction was given in the lecture room, part in the laboratory, part out of doors (under campus trees on the lake shore), and one afternoon per week was devoted to visiting country schools (in order to study medical inspection of the children—especially in connection with the parasitic diseases); these schools were located at various points up to about 20 miles from the campus.

The human being (*Homo sapiens*) was made the center thought; theoretical radii were drawn in all directions, representing the various phyla of the animal kingdom; every zoological subject considered was studied in its practical relations to mankind—medical, welfare, economics, national and international relations, legal, food supply, etc. One of the most popular features of the course was a study of the animals used as food in different parts of the world, for instance, mollusks, arthropods, fishes, amphibia, reptiles, birds and mammals; this gave an opportunity to study classification, biology, commerce, economics, methods of preparation, etc., and was handled chiefly by assignments, thus turning the class into a zoological society.

The reaction of the students was most interesting. Time after time they remarked that they had no idea zoology had so many practical ramifications and could be made so interesting. For some of the students, this was their first course in zoology; others had studied zoology from one to three years in various colleges.

As nearly as I could sense the feeling of the students, they ended the course with a conviction that zoology does not consist solely of theory, Latin names, fresh and preserved animals, and chromosomes, but is actually a part—and an interesting and important part—of their daily life. To some instructors, students' interest in work is evaluated chiefly by the "marks" given; for the benefit of this class of instructor I may add that twelve students received a mark of "A"—which was based on a most critical study of the reaction by and results of the individual members of the class. So high a mark to such a large proportion of a class will seem absurd to many instructors—but even an instructor must play the game fairly with the student and by no stretch of my pedagogic conscience did I feel justified in lowering the marks, for the students had made good.

Toward the end of the term, the class elected three "honorary members," and a tree on the campus is to be dedicated to each of these three men, namely, Professor Irving Fisher (Yale), Dr. L. O. Howard (U. S. Department of Agriculture, retired), and Professor Henry B. Ward (University of Illinois). These elections were based on reviews (presented to the class) of the work of these three men in connection with public health and public health zoology.

From the results of the experiment at Rollins, I can heartily recommend public health zoology as a live subject, of interest and value to college students.

C. W. STILES

U. S. NATIONAL MUSEUM

REGARDING THE C FORMS OF KUHN

UNDER the title, "Über Bakterien und Pettenkoferien," there has recently appeared a small volume[1] by Ph. Kuhn and Käte Sternberg, of Dresden, dealing with bacterial variation and the Pettenkofer bodies (Pettenkoferia), and summarizing earlier observations in this field made since 1919.

I venture to call attention of bacteriologists interested in variation phenomena to the studies of Kuhn, first, because they have an important bearing on the work of myself and associates with the G-forms of bacteria; and secondly, because Kuhn's publications are not commonly known in this country. The matters of special interest treated by this investigator deal with morphological variation and his conception of the parasitism of bacterial cells by a foreign microorganism believed by him to be related to the Myxomycetes. For these parasites Kuhn has coined the name, "Pettenkoferia." Although he has extended, in an ingenious manner, this view of parasitism to include the phenomena of the bacteriophage (alleged destruction of bacteria by attack from the minute and filtrable "spores" of the Pettenkoferia), this unique portion of his exposition does not concern us further at present. I have dealt with this aspect of the problem in detail in an earlier publication.[2]

Kuhn's delineation of variation among the Bacteriaceae is restricted chiefly to the field of cell morphology, and here he has focused attention on five different morphological cell types which he depicts as follows:

> *A-forms* (ameboid forms): These are chiefly round or oval bodies which may sometimes attain the astonishing size of nine microns. They are often ameboid and, in reality, represent the parasitized bacterial cells (Pettenkofer bodies). They seem to be identical with the "giant cocci," "zygospores," "balloon bodies," etc., frequently seen and sometimes reported by courageous bacteriologists for many years. They also include at least some of the so-called "involution forms" of earlier years.
>
> *B-forms* (Bakterienformen): These are represented by the common rod and spiral forms that are regarded by bacteriologists as the "normal" forms of the species. These develop from the slow upgrowth of the C-forms.
>
> *C-forms* (Kokkenformen): These are chiefly coccus forms although the morphology is variable, and some of the bodies are very minute. Colonies of these forms are extremely small and frequently microscopic. The C-forms arise from the B-forms.
>
> *D-forms* (dendritische Formen): These are thick filaments and rods giving root-like branches that are produced by the partial fusion of independent cells or filaments. The morphology is irregular and bizarre. These forms occur among B- or F-forms.
>
> *F-forms* (Fädenformen): These forms are identical with what bacteriologists term "filaments," "thread forms," or much elongated bacteria. They often produce mycelial structures. They commonly develop from the B-forms.

The designations mentioned above were employed by Kuhn to indicate the varying morphology of the cells but were not, with the exception of the C-forms, definitely associated with colony features or with other specific characters.

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[1] Ph. Kuhn and Käte Sternberg, "Über Bakterien und Pettenkoferien," pp. 1–52, Taf. I–XV. Gustav Fischer, Jena, 1931. See also: *Centralbl. f. Bakteriol.*, Abt. 1, Orig., 1931, Vol. 121.

[2] "The Twort-d'Herelle Phenomenon," *Jour. Inf. Dis.*, 42, 263–434, 1928.

It is possible, however, to detect from his more complete descriptions the correlation of his B-forms with the cells of the S type colony and culture; and of his F-forms with the cells of the R type colony and culture. In my experience his D-forms are also most commonly found in R cultures, and I know of no special colony form that is characteristically associated with them. It seems probable that Kuhn's A-bodies (Pettenkoferia) have been most commonly observed by others in association with a type of growth that has been termed "mucoid." These forms are occasionally seen in *B. coli*, *B. typhosus*, *B. paratyphosus*, *B. anthracis* and presumably other species. Mr. Klimek in this laboratory demonstrated them in cultures of the Shiga bacillus on plates undergoing lysis. He also produced them by the action of lithium chloride, as Kuhn had done earlier.

These possible correlations between Kuhn's morphological cell types and colony form need not concern us further at present. A special significance, however, attaches to his "C-forms"; and a consideration of this point is the chief reason for the present communication dealing with Kuhn's studies.

Although I was familiar with his earlier observations and conclusions insofar as they were related to the bacteriophage phenomenon, I had not caught the true significance of his C-forms, perhaps because he reported few data on their filtrability. The matter was first brought to my attention by Dr. Schmidt-Kehl, of Würzburg, late in 1931. Since that time I have been in correspondence with Prof. Kuhn, who, in the meantime, has had opportunity to review our work on the G-forms.[3] I have, in addition, examined his most recently published work, as well as reprints of certain papers published in 1929 and 1930, which Prof. Kuhn kindly sent me.

Kuhn has not reported a special study dealing with the filtrability of his C-forms. But he mentioned the circumstance that he had succeeded in passing through Berkefeld N candles the C-forms of *B. coli*, *B. typhosus*, *B. suipestifer* and *B. diphtheriae*. In ten other species he observed C-forms but the filtrability of these was not discussed. I have no doubt, however, that all of them would have proved filtrable. Despite the few data on filtration reported by Kuhn, a careful review of his published works has convinced me that the G type cultures described by us in 1931 are identical with the C-forms described by Kuhn. They are similar in manner of production (in part), in the type of colony produced, in cell morphology, in viability, in filtrability (in part), in staining characteristics (gram-positive elements in young G cultures of gram-negative bacterial species),[4] in cultural details, in lack of virulence, in resistance to bacteriophage, and in matters concerning their reversion to the "normal" type—a phase of the subject to which Kuhn has devoted special attention and with considerable success. After recently reviewing the report of our work, Kuhn shares this opinion regarding the identity of the two culture forms. It is thus not without interest that, in approaching this problem from quite different angles, we have arrived at a common result, although with different interpretations of the phenomena observed.

I cannot agree with Kuhn regarding the interpretation of these variation phenomena among bacteria (a category of variation which he reduces from a pleomorphism to a dimorphism, embracing only the B- and C-forms). I cannot agree when he states that bacteria multiply only by simple fission, for I believe that reproduction by the formation of gonidia is now well established; and it was because we believed that we could recognize the relation between the gonidial granules and the filtrable forms that we designated them "the G type cultures." Furthermore, I can not accept Kuhn's conclusions regarding the significance of the Pettenkofer A bodies, and their relation to bacteriophagic lysis.

Despite these differences in interpretation, however, I believe that the observations recorded by Kuhn are, in themselves, of much value and significance. I desire, therefore, to make a somewhat belated acknowledgment of his important contributions to our knowledge of this new culture type which stands, as I believe, in an intermediate position between the filtrable, virus-like bodies and the more commonly recognized S and R type cells of many, if not all, bacterial species.

PHILIP HADLEY

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WHALING IN NORTHEASTERN JAPANESE WATERS

AT present the largest whaling station in Japanese waters is located in the Kurile Island group northeast of Kokkaido on the island of Etorofu. On the east coast of this island, in the Bay of Wannippu, whales from northern waters congregate during July and August for feeding and breeding. As far as known, this locality is one of the few places where both breeding and feeding is combined into one area. At times as many as a hundred whales have been known to come to this district in one week. It is thought that certain diatoms play an important rôle in attracting the whale to this isolated region. The feeding ground is less than ten miles from shore and is less than a mile in area.

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[3] Philip Hadley, Edna Delves and John Klimek, "The Filtrable Forms of Bacteria," *Jour. Inf. Dis.*, 48, 1–159, 1931.

[4] This has also been found true of certain G-forms studied by Sherman (personal communication).

Copulation occurs most frequently during August. At times during the breeding season the male whales can be seen in pursuit of the females. Copulation itself lasts from two to three minutes and during the process the tails of the two can be seen together above the water. A young whale is usually about ten to fifteen feet long at birth and is quite able to take care of itself in a general way. The nursing period lasts from twelve to eighteen months and so reduces the mother in weight and quality of the flesh that such an animal is valueless to the whaling industry.

The age of the whale is calculated roughly by means of the quantity of the oil secured from the bone—the larger the amount the older the whale. Life is from thirty to forty years, and the breeding season begins at about the twentieth year.

At Toshimoe, on the eastern coast of Etorofu, the Oriental Whaling Company has established a cutting-in station. As a rule, this station secures a whale a day during the breeding season. Reducing the whale to canable size is accomplished in less than an hour, an amazing speed when one remembers that an ordinary whale weighs something over 30,000 pounds! The blubber oil is used for machine oil. The best grade is secured by means of steam pressure upon the bones. Such oil is best for fine lubrication, clock and watch oil. All parts of the whale are used, including the small intestines as food and the large intestines as fertilizer!

On the eastern coast of Etorofu the Sei whale is the most common. This whale is spotted with white, otherwise little different from the Arctic. Second in frequency is the Arctic, and rarest is the Sperm. On the west coast at Shana, where another breeding locality is found, the exact reverse is true, the Sperm whale being the most frequent, followed by the Arctic and Sei. This may be accounted for on the theory of warm waters, the east coast being in the cold stream and west coast being in the warm Japanese current. Since the establishment of the station at Toshimoe some twelve years ago, over 650 whales have been secured. Of these only twelve were Sperm, a hundred Arctic and the remainder Sei whales. Only once during the operation of the company has ambergris been found—that was off the coast of the main island of Japan, near Sendai. The profit resulting was something like $250,000. The cause, as is well known, is due to an irritation caused by the lodging in the small intestine of a small devil fish. Such infected whales have large raw sores over the body and produce an extremely bad odor.

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SCIENTIFIC BOOKS

Flora of the Prairies and Plains of Central North America. By P. A. RYDBERG. New York Botanical Garden, Fordham Station, Bronx Park, New York, N. Y. 1932. $5.50 postpaid.

HERE in the plains and prairies we have labored with many manuals, claimed by none, divided by many. Now we come into our own with a manual of ferns and seed plants devoting itself exclusively to us. The region covered includes "the states of Kansas, Nebraska, Iowa, Minnesota, South Dakota, North Dakota and of southern Manitoba and south-eastern Saskatchewan," together with most of the species in the prairie regions to the east and west across the plains to the Rocky Mountains.

Dr. Rydberg spent many of his earlier and some of his later years in studying the plants of this region. A few years ago he set out to embody this study in a manual that would cover this region exclusively. Although death unfortunately overtook him in the midst of proof sheets, the essential part of the manuscript was complete.

I like to think that the complete purpose of a taxonomic manual is to give names to plants, to show the relationship between plants and to furnish practicable or useful methods of identifying the plants that may be collected in the region covered by the manual.

The first of these purposes is thoroughly handled by this book, in accordance with the international code of nomenclature. The principal objection lies in the occasional "splitting" of certain well-known genera and less frequently of families. As it is a matter of opinion, therefore, of interminable argument, I can only say that the same systematic results could be obtained by using sections for the large genera and if the subrelationship is particularly necessary, the scientific name can then be written, to give but one example, *Astragalus* (*Geoprumnon*) *crassicarpus*. This would give the name, show the relationship and not take it quite so far from closely related plants that only the professional systematist would be able to keep track of it. This side of systematic botany, namely, practical utility, is not infrequently overlooked by the professional botanist, and yet it is the side which is often likely to give encouragement and support to his studies. Perhaps if the elimination of the name of the person who made a change of genus were made, the tendency to split genera would be greatly reduced.

From a genetical standpoint, the arrangement of the manual is based on the Engler system, a system which is based on a preponderance of untenable propositions. To many the arrangement is of little importance, but a natural arrangement is of considerable assistance in establishing a comprehensive viewpoint in teaching taxonomy.

These points do not alter the fact that now we have concise descriptions of the 3,988 ferns and seed plants of the prairie-plains region in one book. The plants are well keyed in a standard manner. The time of blossoming or of fruiting is given and the ranges include the complete range of the plant. In addition there is a glossary and 600 pen sketches, illustrating at least one species each of about two thirds of the genera.

Although the book is quite complete systematically, one regrets that Rydberg did not live to add the phytogeographic discussion that was planned.

A list of abbreviations of authors' names by J. H. Barnhart completes the 969-page book. This book thus fills a long-felt want and will prove indispensable for work in the region covered.

To Dr. Marshall A. Howe, of the New York Botanical Garden, goes a great deal of credit for seeing the work through publication. Particularly is this credit to be acknowledged for the great care he has taken to have the work come out as nearly perfect as possible in a field quite outside of his own.

Frank C. Gates

Manhattan, Kansas

SOCIETIES AND ACADEMIES

THE OHIO ACADEMY OF SCIENCE, 1932

The Ohio Academy of Science held its annual meeting for 1932 at Ohio Wesleyan University, Delaware, Ohio, from April 28 to 30, with about 200 members and visitors present, the program taking the usual form of business meetings (two), a general scientific session (one), and section meetings (eleven). An outstanding feature of the general scientific session was a motion-picture film showing the treatment of osteomyelitis with blowfly larvae by Drs. D. F. Miller, C. A. Doan and E. H. Wilson, of Ohio State University. In the sectional meetings some 141 papers were presented as follows: *Zoology,* Dwight M. DeLong, vice-president, 32; *Botany,* Arthur T. Evans, vice-president, 15; *Geology,* E. M. Spieker, vice-president, 19; *Medical Sciences,* Shiro Tashiro, vice-president, 25; *Psychology,* Horace B. English, vice-president, 15; *Physical Sciences,* Forrest G. Tucker, vice-president, 21; *Geography,* Eugene Van Cleef, vice-president, 14. A few of these papers will be published in full and abstracts of many others in the July, 1932, issue of the *Ohio Journal of Science,* which issue will be devoted almost entirely to the Proceedings of the annual meeting.

The annual banquet on Friday evening was a notable event, as it was on this occasion that President Smith delivered his scholarly presidential address on "Physics and Human Experience"; the banquet was notable also in the matter of attendance and various and delightful social features.

The academy put itself on record as unanimously in favor of a water conservation survey in Ohio (H. R. Bill 6478, Senate substitute 1704), the extension of a water conservation program, the conservation and preservation of wild flowers as outlined by the Wild Flower Preservation Society and the Central Ohio Anglers' and Hunters' Club, the setting apart of suitable areas in state parks as wild life sanctuaries to be free from disturbance of natural conditions and not open to picnic or camping parties or to provision of roadways or paths, legislation to protect hawks and owls and making the use of the pole trap illegal.

Some sixty new members were elected and the following members were elected to fellowship in the Academy: S. Prentiss Baldwin, Homer G. Bishop, Albert F. Burgess, Harry F. Dietz, Winston E. Dunham, Harold A. Edgerton, Linden F. Edwards, Ray Lee Edwards, Robert M. Geist, Louis D. Hartson, Robert A. Hefner, Neale F. Howard, Ralph A. Knouff, Chester O. Mathews, Francis N. Maxfield, Zeno Payne Metcalf, Claude R. Neiswander, James Ruey Patrick, Sidney L. Pressey, John W. Price J. P. Sleesman, Isabel S. Smith, Guy Harold Smith, Laurence H. Snyder, Augustus W. Trettien, Richard S. Uhrbrock, Willard L. Valentine, Eugene Van Cleef and George W. White.

The following officers were elected for the ensuing year:

President: R. A. Budington.

Vice-Presidents: Zoology, W. C. Kraatz; *Botany,* Bernard S. Meyer; *Geology,* Carl Ver Steeg; *Medical Sciences,* F. A. Hitchcock; *Psychology,* L. D. Harston; *Physical Sciences,* A. A. Atkinson; *Geography,* Geo. D. Hubbard.

Secretary: William H. Alexander.

Treasurer: A. E. Waller.

To Executive Committee: Alpheus W. Smith and M. E. Stickney.

To the Joint Administrative Board of the Ohio Journal of Science: E. L. Rice and C. G. Shatzer.

W. H. ALEXANDER,
Secretary

THE TENNESSEE ACADEMY OF SCIENCE

THE Tennessee Academy of Science held its 1932 spring meeting on April 22, 23 and 24 at Memphis and Reelfoot Lake. Three sessions and the academy dinner on Friday evening, April 22, were held in the ballroom of the Peabody Hotel. Twenty-four papers were contributed by members from Memphis, Jackson, Nashville, Knoxville, and Franklin, Kentucky.

Dr. A. Richard Bliss, Jr., president, presided at the academy dinner, and Dr. Martin H. Fischer, professor of physiology in the University of Cincinnati, delivered an address on the "Constitution of Living Matter," illustrated with charts and chemical experiments. Three hundred and seventy-four members and guests were registered at the meeting in Memphis, and 154 attended the dinner.

On Saturday afternoon the non-resident members were taken in automobiles to Walnut Log Lodge, on Reelfoot Lake, where the fourth session was held that evening. The program consisted of a "Symposium on Reelfoot Lake," with special reference to its suitability as a location for a biological laboratory.

Several papers were devoted to the geographic and geologic features of the lake, its acquisition by the state for a public park and the setting apart by the 1931 General Assembly of ten acres and a building for a biological station for research, to be under the management and control of the Tennessee Academy of Science and an appropriation of $2,500 towards outfitting.

Following these were papers by the state commissioners of education, agriculture and public health on the value of such an institution to the state, and by the president of the Southwestern University on the interest and patronage of colleges and universities.

The remarkable richness of the lake and its environs in forms of vegetable and animal life was brought out by the state forester and the state game and fish warden and by Professors Jesse M. Shaver, of George Peabody College, Clarence E. Moore, of the West Tennessee Teachers College, and A. John Schwarz, of the University of Tennessee.

Dr. A. Richard Bliss, Jr., chairman of the habilitation committee, reported that the Cantillon Club House of eight rooms would be ready for use as a laboratory early next summer, the Walnut Log Lodge near-by to be used for residence of workers.

At a meeting of the Reelfoot Lake Biological Station trustees held on the morning of April 24, an executive committee was established, consisting of A. Richard Bliss, Jr., chairman, James B. Lackey, Richard G. Turner, Jesse M. Shaver, J. T. McGill, ex-officio, and the following resolution was adopted:

> That the board of trustees of the Reelfoot Lake Biological Station invite the Tennessee State Departments of Education, Agriculture and Public Health, a number of universities and colleges and selected scientific organizations, each to appoint one or more research workers to take part in a physical and biological survey of Reelfoot Lake and its environs, to begin June 1, 1932.
>
> Each department or institution may make such provision for expenses as it deems advisable.
>
> Reports of the work are to be made to the trustees.

JOHN T. MCGILL,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONVENIENT METHOD OF PHOTOGRAPHING SMALL ANIMALS AT LOW MAGNIFICATION

DURING work on planarians I desired to take pictures of living animals in locomotion. The small size of the animals demanded pictures on an enlarged scale. Since in biological laboratories the need of photographing small living animals at low magnification frequently occurs, I will describe a method, which, in spite of its simplicity, leads to good results.

Photography on an enlarged scale requires either a relatively long exposure or a very intensive illumination of the photographed object. The intensity of the image formed by the lens on the photographic plate decreases as the square of the magnification increases. In order to take a picture of an object, *e.g.*, 5 times enlarged, it is necessary to use an exposure 25 times longer or stronger than for a picture in natural size. If a moving object has to be photographed, then the duration of the exposure is limited. It has to be considered that the speed of the motion in the image increases at the same rate as the magnification. A planarian, *e.g.*, which glides along with an average speed of 12 cm per minute and which has to be photographed five times enlarged, will move in the image with a speed of 60 cm per minute or 10 mm per second. To obtain a sufficiently sharp picture the exposure must not be longer than 1/50 second, if we suppose that a contour appears sharp when it is not broader than 0.2 mm. Should one wish a still sharper outline, *e.g.*, not broader than 0.1 mm, one would have to shorten the exposure even more (1/100 second). The picture can not be taken except by employing an extremely strong source of light or by using proper arrangements to concentrate light on the object. This difficulty increases when the depth of focus has to be improved by choosing a small diaphragm.

The main problem in taking pictures of this kind is therefore the question of the source of light. One may use for this purpose the "Edison Mazda Photoflash Lamp," which has recently appeared on the market. This is a glass bulb in the same shape as an electric light bulb, filled with oxygen and furnished with an aluminum foil. The aluminum may be ignited by an electric current and burns within the bulb, giving a very strong and fairly short flash (according to the statement of the manufacturers about 1/50 second).

A camera of the type of vertical cameras for microphotography has been used (Fig. 1, C). Such a camera is kept in most of the biological laboratories. It combines two advantages: it allows great variation in the length of the bellows and takes pictures in a horizontal plane. Any other camera with similar characteristics will, of course, work the same way. The lower opening of the camera, which in microphotographic work is set on the eyepiece of a microscope, is closed with a photographic lens (L) with short focal length (about 5 cm). The animals are put into a shallow dish (D), *e.g.*, a Petri dish, and placed under the lens at the proper distance. The picture is focused on the ground-glass plate with the lens entirely open. It is necessary to mark the field of vision of the ground-glass plate on the Petri dish. That may be done by putting under the dish a sheet of dark paper with a properly shaped opening. Then a flash-bulb (F) is placed close to the dish (it may be as close as 15 cm), so that its light will fall on the object obliquely from above. Care must be taken that no light falls directly on the lens or is reflected to it from the water surface. The illumination is improved by a reflector (R) fixed behind the bulb. One may use a common table lamp with a reflector, substituting the flash-bulb for the light bulb. A sheet of white cardboard (B) on the opposite side of the object may be used to increase the lighting by diffuse reflection.

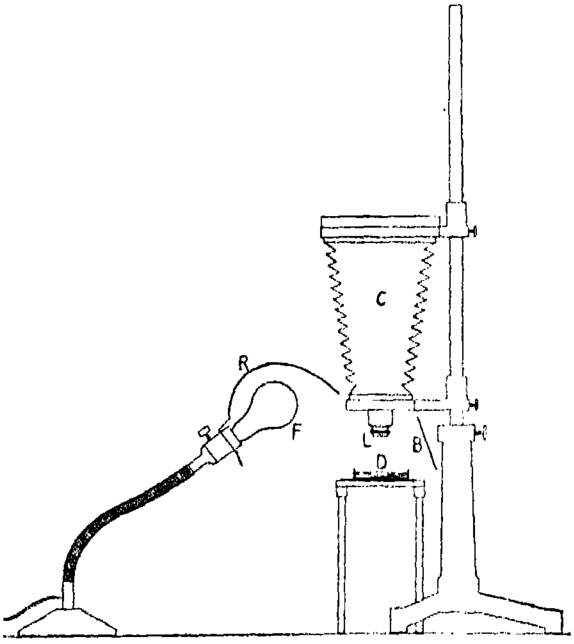

FIG. 1. Diagram of the arrangement of apparatus for taking pictures of small animals. (B) White cardboard for reflecting light; (C) camera; (D) Petri dish containing animals; (F) flash-bulb; (L) photographic lens; (R) reflector.

After these preparations the diaphragm is adjusted in order to obtain a proper depth of focus. In an enlargement of five times and in employing ordinary double-coated plates with fine grain (and therefore with only mediocre speed) a diaphragm with an opening of F/16 is permissible. The ground-glass plate is changed for the photographic plate. It is convenient to work in a room with dim artificial light. Then the lens may stay open for quite a while without the plate being affected by the incident light. No high-speed shutter is necessary.

The picture is taken when an animal is moving over the marked space in the dish in proper position and shape (planarians may to a certain extent be directed in their moving by a weak source of light). The exposure is made by igniting the flash bulb by turning an electric switch.

It is often advisable to photograph a small scale with the animal. Thus one may later check the magnification in the pictures.

In photographing water animals one must take care that no dust particles are floating on the surface of the water. These could spoil the picture by forming small depressions on the surface and so destroying the sharpness of the picture locally.

This method of directly photographing small objects at low magnifications may be useful also in other cases where a short exposure of the object is necessary.

ROMAN KENK

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PERMANENT PRESERVATION OF THE HUMAN BODY BY INFILTRATION

A METHOD for preservation of small animals by paraffin infiltration has been previously described by

Dr. G. K. Noble, of the American Museum of Natural History. This note briefly summarizes a method for permanent preservation of the human body by paraffin infiltration.

Four essential steps, well known to all familiar with histological methods, are necessary to preserve a specimen—fixation or embalming, dehydration, clearing and embedding. The different solutions used in the above steps were injected by way of heart and vascular system, and at the same time the specimen was immersed in the solutions.

The embalming fluid which maintained the color of the skin and lips most nearly normal was a solution containing liquor formaldehyde 10 per cent., sodium borate and sodium chloride each 1 per cent. Fixation required about ten days.

Dehydration and hardening was accomplished by gradually increasing strengths of alcohol. Dehydration required about forty-six days.

Xylol containing 5 per cent. of liquid carbolic acid was used as a clearing medium. Clearing required about one week.

Paraffin infiltration was accomplished by means of continued injection of paraffin through the vascular system, together with complete immersion of the body in heated liquid paraffin. Embedding required about one week.

The excess paraffin was removed with xylol and washing under running hot tap water.

In all, experience indicates that adult subjects can be preserved by the above method in about seventy days.

A still-born Negro infant has been successfully infiltrated and embalmed by the technique above described. Unlike mummies of old with their characteristic loss of color, shrinkage, removal of organs, artificial replacements, etc., this infant is preserved *in toto,* retaining its original form and identity in every respect. So natural does it appear that any one would readily mistake it for a living child.

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SPECIAL ARTICLES

GENERAL THEOREMS IN DYNAMICS

I wish to state some new and simple theorems concerning the motion of a particle in a general field of force. The proofs will be published elsewhere. The results concern the relation between the lines of force and the paths or trajectories. We consider first the case of a particle starting from rest, then a particle projected in the direction of the acting force, then an arbitrary direction.

If a particle starts from rest, it begins to move along the line of force and then deviates from it on account of its acquired velocity. The path and the line of force will, therefore, have the same tangent but different curvatures.

Theorem I: *The main result is that the curvature of the trajectory obtained by starting from rest is one third the curvature of the line of force.*

A separate discussion is necessary when, at the given point, the curvature of the line of force is zero, as for a point of inflection, for then both curvatures vanish. In this case we consider the ratio of the infinitesimal departures of the two curves from the tangent line. In the main case this ratio would be $1:3$; but now it is found to be $1:5$, $1:7$, $1:9$, etc., depending on the order of contact with the tangent line. It is always of the form $1:2n+1$.

Theorem II: *If the line of force has contact of n-th order with the tangent line, the trajectory produced by starting a particle from rest will also have contact of n-th order; and the ratio of the departure of the trajectory to the departure of the line of force from the common tangent will be* $1:2n+1$.

Theorem III: If the particle is projected in the direction of the force with a speed different from zero, the initial curvature will be zero and the departure from the common tangent will vary inversely as the square of speed.

It follows, from I and III, that if any dynamical trajectory touches a line of force it will, at that point, either have zero curvature, or else its curvature will be one third that of the line of force.

Theorem IV: The single infinity of paths obtained by starting at a given point in the force direction with varying speed under the conditions of Theorem II, will have contact of order $n+1$, and will give departures from the common tangent varying inversely as the square of the speed; except for the single path due to zero speed for which case the contact will be of n-th order and the departure ratio will be of the form $1:2n+1$.

These theorems apply to any continuous differentiable positional field of force, conservative or not, in flat or curved spaces of any dimensionality; and therefore can be used, for example, in the gravitational field of an elliptical planet, or in the problem of three bodies, or in the complicated magnetic field of the earth.

If there is a resisting medium, like the air, Theorem I will still be valid. This is true whenever the resistance R_0 due to zero speed vanishes.

THEOREM V: If R_o does not vanish, as in the case of sliding friction, the ratio of the curvatures is $1:3+2\frac{R_o}{F}$ where F is the acting force.

We observe that Theorem V includes Theorem I as a special case.

If a particle starts from a given point in a given general direction (not the force direction) with varying speed v, we study, in the last part of the paper, the variation of the successive radii of curvature $r, r_1, r_2, \ldots$, and the loci of the successive centers of curvature $C, C_1, C_2, \ldots$ of the successive evolutes of the trajectories. The results for r_1, (quartic law) and C_1, (parabolic locus), and also Theorem I about the ratio 1:3, were given in earlier papers by the writer (Trans. Amer. Soc. Math. 1905–1910; Princeton Colloquium Lectures, *Differential geometric aspects of dynamics*, 1913; an application of Theorem I is given by W. H. Roever, *Bull. Amer. Math. Soc.*, 1915, p. 456). For r and C the results are obvious. The general results are as follows:

THEOREM VI: *The locus of* C_n *is a rational curve of order* $n+1$. *The radius* r_n *of the nth evolute of the trajectory varies as a polynominal of degree* $2n+2$ *in the speed v.*

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SOIL WEIGHTS BEFORE AND AFTER DISPERSION

THERE appears to be a rather common belief among soil chemists and physicists that a soil, after dispersion, may weigh more than before dispersion, the dry weight at 105° to 110° C. being used as the basis of comparison. In this laboratory it was first observed, some ten to twelve years since, that, in the quantitative separation of colloidal material from soils, sometimes the total weight of the fractions into which the material was separated apparently exceeded the weight of the original sample. A somewhat similar observation has more recently been made in carrying out mechanical analyses of soils by the pipette method.[1] In this procedure the soil sample, after dispersion, is wet-sieved so that the clay and fine silt are collected in the sedimentation cylinder. By deducting the dry weight of the sands and coarse silt from the dry weight of the sample before dispersion, the weight of the material in the sedimentation cylinder may be obtained. The weight of this material may also be estimated by removing an aliquot from the sedimentation chamber, evaporating to dryness, and weighing. In practically every case where this check was made it was found that the direct determination by the aliquot method gave a slightly higher value than did the determination by difference. It is to be noted that such difference may be occasioned by an error in the aliquot used, which error is magnified by the aliquot multiple. However, it has been usual to attribute such assumed increases of weight to combination with water when the colloidal aggregates are broken apart by dispersion and a greater total surface is exposed. The added water is sometimes spoken of as "water of hydration."

The assumption of weight increases is not wholly absurd. If, as is the usual thought, soil colloids are produced by hydrolysis of minerals, the "water of combination" of the colloids has been added by just such a process. Further, from experiments with silica gel and with charcoal, it appears that microscopic particles are exceedingly effective in condensing and holding vapors. The dispersion procedure breaks down the structure of many of the colloidal particles formed by repeated wetting and drying in the field. New particles are formed when dispersed soil is dried, and it is possible that these new particles may have a different holding capacity for water than the field particles.

It seems, indeed, quite inconceivable that the time required for soil dispersion can effect any measurable increase in the hydrolysis of unhydrolyzed minerals above that effected in the field during the almost infinite period of formation of the soil. It seems quite improbable that any addition products would be formed by dispersion, and remain stable at 105°, which can not be formed and remain equally stable under field conditions. Nevertheless, the belief in the weight increase, as noted above, seemed so general that it appeared worth while to attempt to determine whether it actually does occur. For this purpose the work reported in this report was carried out.

THE SOILS EMPLOYED

Three soils were used. The sample of Cecil clay loam was taken from the soil profile of the Erosion Experiment Station at Statesville, North Carolina. The B horizon, 6–32 inches, was used. It contains 12.1 per cent. silt and 57.1 per cent. clay. It is a lateritic soil, low in organic matter, low in base content and in exchange base capacity. The finer particles are cemented together rather firmly and it disperses with difficulty.

The sample of Beckett silt loam is a part of a profile taken in a forested area in Massachusetts. The B_2 horizon, 13–24 inches, was employed. It has 30.2 per cent. silt and 9.0 per cent. clay. The Beckett is a podsol soil and is exceptionally acid (pH = 4.1) in this horizon. While it has a fairly high exchange base capacity, it is low in bases. The organic matter and iron-oxide content are both high.

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[1] U. S. D. A. Tech. Bul. 170, p. 19.

The sample of Amarillo silt loam is from a profile obtained in Potter County, Texas. The stratum used was that from 10 to 20 inches in depth. It has 41 per cent. silt and 47.4 per cent. clay. The Amarillo is a chernozem soil fully saturated with bases.

The descriptions, though brief, are sufficient to show that the soils selected were developed under a wide range of climatic conditions and offer a fair range of physical and chemical characteristics. It is believed that if increase in weight, as a result of dispersion, is a phenomenon of common occurrence, it should be shown by one or more of these soils.

EXPERIMENTAL DATA

Duplicate air-dry samples, of 2.5 grams, were weighed into Erlenmeyer flask-shaped weighing bottles of 30 cc capacity. The weighing bottles were then put in a vacuum desiccator and the air removed with a vacuum pump having a rating of 0.01 mm pressure. The pressure remained constant at 4 mm for several hours under continuous operation of the pump. After 24 hours evacuation the pressure became too low to read on the manometer and was probably less than 0.1 mm. The samples were weighed on successive days until the weight became constant. Twenty-two cc of water, slightly alkaline with ammonia, were added and the flasks were shaken for 50 hours in a reciprocating shaker. The flasks were then placed in a desiccator and dried under half an atmosphere pressure at 35°. The drying was exceedingly slow. When all visible moisture had been removed, the drying *in vacuo* was completed exactly as in the initial drying. This method of drying before and after dispersion was used in order to avoid the known alteration of weight of organic matter at 105– The initial and final weights are given in le 1.

samples were allowed to stand for several days in the laboratory and then dried over night at 105° C. The changes in weight from the previous drying are given in the last two columns of Table 1. The small increases noted for the Cecil and Amarillo samples are probably due to air absorbed and the loss in the Beckett to change in the organic content.

This experiment, having failed to demonstrate the point at issue, under conditions presumably favorable to increase in weight after dispersion, if such increase actually occurs, might seem conclusive. However, soils are usually dried at 105–110° C. and therefore the experiment was repeated in modified form. For this purpose four samples of each of the soils were brought to like condition of humidity by standing in a desiccator over sulfuric acid, with a relative humidity of 65 per cent., until they ceased changing in weight. They were then accurately weighed. Each sample weighed approximately three grams. One sample of each was dispersed with 22 cc of distilled water. One of each was dispersed with 22 cc of 0.2 N. ammonium hydroxide. They were dispersed by shaking for 32 hours on a reciprocating shaker. The dispersed samples were then dried on a water bath until visible water had disappeared and were then placed in an oven at 105° The remaining two samples of each soil were placed in the same oven under identical conditions and dried over night. The undispersed samples were in duplicate in order to show the degree of accuracy obtainable. The experimental results are given in Table 2.

Instead of recording in the table the actual initial weights of the samples, the data are recalculated on the basis of exactly 3 grams each and the oven-dry weight corresponding to this given in column 5. The last column in Table 2 gives the difference between the oven-dry weight and the mean value of the undispersed samples. It may be observed that the deviations of the dispersed samples are of the same order of magnitude as those of the single undispersed samples, the largest being but 3 mg. The total dry weight of the dispersed samples is but 1 mg. less

TABLE 1

VACUUM-DRIED SOIL WEIGHTS BEFORE AND AFTER DISPERSION

Lab. No.	Soil series	Initial weight by vacuum drying		Final weight by vacuum drying after dispersion		Change in weight after dispersion		Change in weight at 105° C.	
		Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
		gm	gm	gm	gm	gm	gm	gm	gm
6978	Cecil	2.4583	2.4580	2.4599	2.4597	+.0016	+.0017	+.0031	+.0036
4447	Beckett	2.4596	2.4607	2.4590	2.4600	-.0006	-.0007	-.0055	-.0038
4575	Amarillo	2.4169	2.4166	2.4207	2.4211	+.0038	+.0045	+.0039	+.0039

It will be observed that the results are essentially negative. That is, the weight changes are very slight and of the order of magnitude of the unavoidable errors of the experiment. The maximum increase is but 0.18 per cent. After the final vacuum drying the

TABLE 2
CHANGE IN WEIGHT OF SOILS AT 105° C.

Lab. No.	Soil series	Sample treatment	Initial weight	Oven dry weight	D[illegible] fro[illegible] ov[illegible] of[illegible]
			gm	gm	[illegible]
6978	Cecil	Air dry (1)	3.0000	2.9231	[illegible]
"	"	" (2)	3.0000	2.9225	[illegible]
"	"	Dispersed with ammonia	3.0000	2.9258	[illegible]
"	"	Dispersed without ammonia	3.0000	2.9241	[illegible]
4447	Becett	Air dry (1)	3.0000	2.9294	[illegible]
"	"	" (2)	3.0000	2.9304	[illegible]
"	"	Dispersed with ammonia	3.0000	2.9300	[illegible]
"	"	Dispersed without ammonia	3.0000	2.9278	[illegible]
4575	Amarillo	Air dry (1)	3.0000	2.8106	[illegible]
"	"	" (2)	3.0000	2.8136	[illegible]
"	"	Dispersed with ammonia	3.0000	2.8114	[illegible]
"	"	Dispersed without ammonia	3.0000	2.8110	[illegible]

than that of the undispersed samples. On the basis of this experiment, therefore, if any weight change occurs as a result of dispersion, it does not exceed 0.1 per cent. It is to be observed that a very small increase in weight should occur in acid soils dispersed with ammonia, since ammonia adds itself directly to acids and this addition has been repeatedly demonstrated in soils. In the case of the Cecil sample such an increase is noted. The total base capacity of the Cecil is about 1 milliequivalent per gram and the absorption of this quantity would mean an increase in the sample used of 2.5 milligrams. No such difference should occur in the Amarillo soil and indeed the difference between the weights of the sample dispersed in ammonia and that in water is less than that of the undispersed samples. The Beckett soil is also unsaturated like the Cecil, and shows a difference of about 2 mg between the sample dispersed in ammonia and that in water. Both show negative values which are probably properly ascribed to loss of organic matter during the evaporation of the dispersed material. The differences in the weight of the undispersed samples, while not large, are probably due to actual lack of uniformity in the samples themselves which were sieved to pass a 2 mm sieve. Closer duplication might have been secured by finer grinding of the material.

The results obtained are essentially negative. There is no appreciable increase in weight of dry samples as a result of dispersion in water. The writers realize, of course, that as soils are ordinarily dispersed, much greater dilutions of soil by water are employed. The concentrations employed were used in order to minimize any possible loss in handling. It seems improbable that greater dilution would give greater hydration. Also, while in the normal pr[illegible] [illegible] persion the colloid and coarser material are [illegible] weighed separately, there would seem [illegible] soils so high in clay as these employed to be [illegible] son why separate drying should alter the matte[illegible] writers are also aware that these experim[illegible] prove that hydration of soils by dispersi[illegible] curs. They do show that if such result w[illegible] and of appreciable magnitude, it should h[illegible] in the soils examined. It seems desirabl[illegible] results on record and to request that [illegible] worker can furnish reproducible data to s[illegible] crease in the dry weight of soils result[illegible] persion, he will likewise communicate the[illegible] is worth while to determine whether th[illegible] mythical or if it constitutes a real ex[illegible] accurate data.

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